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TRACKER ANTENNA LOCATION STUDY.(U)
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(6) TRACKER ANTENNA LOCATION STUDY,

by

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ABSTRACT

This report details the antenna location study for the Tracker Aircraft refitment. Computer prediction of electromagnetic interference and antenna coupling in conjunction with antenna pattern measurements made on a scale model of the Tracker yielded suggested locations for the new antennas.

RÉSUMÉ

Le présent rapport porte sur une étude détaillée de localisation des antennes du Tracker dans le cadre de sa remise en service. Les positions prévues des nouvelles antennes ont été déterminées à partir de prévisions numériques des interférences électromagnétiques et du couplage des antennes, ainsi qu'à partir des mesures des configurations des antennes telles qu'obtenues au moyen d'un modèle réduit du Tracker.

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1. INTRODUCTION

A task was initiated by DAEM-6 to have DREO carry out an antenna location study for the refitment program on the Tracker aircraft. The task was approached in two ways. An analysis using an existing computer program was used to compute antenna to antenna coupling and interference between equipments. The second approach entailed making antenna pattern measurements on a 1/15 scale Tracker model. The latter was performed by CRC for DREO.

The Tracker was recently assigned the job of policing the new 200 mile Canadian territorial fishing limit. To perform their new task it was necessary to eliminate their anti-submarine capability and add new equipment which would extend their cruising range, give them all weather capability, enable them to locate and identify fishing craft and improve their navigation system. At the same time outdated equipment had to be replaced.

The additional equipment included the ARN508 (VOR/ILS), AR201(VHFFM), ARC511A (VHFAM), and ARN509(Omega). Replacement equipment included APS504 (Search Radar), ARN504(Tacan), and APX77(Transponder). The replacement equipment used existing antennas. The new antennas which were studied were the VOR/ILS Glide Slope(Collins 37P-4), Marker Beacon (37X-2), VOL/LOC (Collins 837-1A), the VHFFM (Collins 37R-5), and the VHFAM (Collins 37-5). The location for the new Omega antenna was to be determined by the manufacturer.

Optimum antenna location was to be based on minimum coupling between antennas of interfering equipment and most acceptable antenna pattern coverage. In addition to determining the optimum antenna locations an electromagnetic compatibility (EMC) study was carried out to identify possible interference situations. Section 2 gives further details of the antenna modelling and computerized prediction approach. Section 3 gives the results. A discussion of the individual systems is given in Section 4. Conclusions are found in Section 5.

2. APPROACH

2.1 COMPUTER PROGRAM

The computerized EMI prediction program used in this study is called "Antenna to Antenna Compatibility Analysis Program" (ATACAP) and was developed by McDonnell Douglas Aircraft Corporation. The program determines frequency coincidences between the emitters and receivers on the aircraft then calculates an EMI margin (EM). The EM is defined by:

$$EM = P-TL-S \quad (db) \qquad \text{Eqn. 1}$$

where P = emitter power in dbm

TL = transfer loss between transmitter and receiver in db

S = sensitivity threshold of the receiver in dbm.

EM = EMI margin in db

Ideally a positive EM would indicate interference and a negative EM would indicate no interference. However, due to the inherent inaccuracies in the models and the inaccuracy of the input data the program can only realistically help define areas of probable, questionable and doubtful interference. The "grey" region within about 10 db of EM equal to 0db would require further testing. Each element of Eqn. 1 must be modelled analytically. The models may be derived empirically or theoretically. In either case they require detailed input data. An outline of the models required for the prediction program follows.

2.1.1. Emitter Model

The emitter model makes use of equipment parameters to represent the emitter output spectrum. One model used is shown in Figure 1. In this case the output power is assumed constant over the entire tuning range and the shapes of the harmonic curves are the same as the fundamental although displaced downward. The undesired output levels are derived from an EMI emission specification. The basic input data required by the emitter model are: frequency tuning range, power output and emission bandwidth.

2.1.2 Receiver Model

The receiver model must represent the receiver's susceptibility to incoming signals over the frequency range of interest. The susceptibility function is shown in Figure 2. The susceptibility is constant over the tuning range of the receiver and is assumed equal to the in-band sensitivity. The skirt slope is given by the receiver selectivity. The input data required by the receptor model includes frequency tuning range, sensitivity, bandwidth and selectivity.

2.1.3 Antenna to Antenna Coupling Model

This coupling model determines the loss between two antennas on an aircraft due to the free space distance between them, the curvature of the fuselage and the diffraction loss around the wing edges. The free space transmission factor, TFS, is found by using the Friis transmission equation (Ref. 1).

$$TFS = GX + GR + 20 \log 10 \left[\frac{\lambda}{4\pi D}\right] \qquad \text{Eqn. 2}$$

where

GX = gain of transmitter antenna in db.

GR = gain of receiver antenna in db

D = distance between the two antennas in meters

λ = wavelength in meters.

The antenna gain is obtained from the mathematical models of the antenna radiation pattern. Low gain antennas are modelled analytically by a trigonometric expression. High gain antennas are modelled by a three dimensional, two sector representation as shown in Figures 3a and 3b.

The distance between antennas used in Eqn. 2 is obtained from a geometrical approximation to the complex aircraft structure. Figure 4 shows the model used by the program. The antenna separation is determined by a combination of straight lines, conical spirals and/or cylindrical spirals that gives the shortest distance.

The fuselage shading factor is calculated when a portion of the propagation path is around the fuselage. The shading factor is derived from the work of Hasserjian and Ishimaru (Ref. 2) in which the propagation around an infinite conducting cylinder as related to that over a flat plane. The relation used is given by:

$$SFc = \frac{A}{\eta A + \xi}$$

where $A = \rho_f \Theta_s^2 \sqrt{\frac{2\Pi}{Dc}}$

5.478×10^{-3} for A<26

3.340×10^{-3} for A≥26

$$\xi = \begin{cases} 0.5083 \text{ for } A < 26 \\ 0.5621 \text{ for } A \geq 26 \end{cases}$$

and SFc = fuselage (cylindrical) shading factor (db)

ρ_f = radius of cylinder (meters)

θ_s = angle around cylinder of propagation path (radians)

λ = wavelength (meters)

Dc = distance of cylindrical segment of propagation path (meters)

When a portion of the propagation path is around the wing or any surface edge a wing shading factor (SFW) is calculated. An electric field incident on an edge can be related to the diffracted electric field using optic theory Ref. 3 and 5. The total shading factor is the sum of the fuselage and wing shading factors. The total transfer loss is the combination of the free space transmission loss, the shading factors and coaxial cable loss. This value is then used in Eqn. 1 to determine the EM for the particular interference case. Four basic types of interferences are predicted by the program: transmitter fundamental or harmonic output with receiver fundamental or spurious response. The program printout identifies the EMs and the three antenna isolation components; free-space, wing shading, and fuselage curvature.

2.2 ANTENNA PATTERN MEASUREMENTS

Antenna pattern measurements were made on a 1/15 scale model. The model scale was determined by the limiting frequency of the test facility (30GHz) with consideration given to the practical physical size for the mounting of antennas and mixers. The low frequency limit of the anechoic chamber precluded the modelling of the new Omega equipment. Measurements were made in the indoor range which was of sufficient length to ensure that antenna far-field conditions would apply.

The aircraft model was made of wood then sprayed with conductive silver paint. A microwave reflection test was made to assess the suitability of this fabrication technique. A comparison of the reflection from a metal plate to that from a silver sprayed wood sample was made. No significant difference was observed. Non-conducting apertures were included in the model as were landing gear and hinged tail rudder. Provision was made for mounting the aircraft in three positions; from the top, from the bottom and from nose to tail. The mounting position chosen depended on the location of the antenna under test and the type of pattern being measured.

Figure 5 shows the model mounted on the positioner. The pattern recording instrumentation was syncronized with the positioner drive to allow fully automatic pattern measurement. The positioner also permitted the standard coordinate system to be used (Figure 6). The pole of the spherical coordinate system is the yaw axis of the aircraft. The Ø coordinate and angular rotation about the yaw axis are then measured as indicated. Further details of the instrumentation, construction and measurement technique are given in a CRC report (Ref. 6).

The antenna patterns were taken in two standard formats, polar plots and rectilinear plots. All of the patterns (over 500) were taken on rectilinear paper while just the three principle plane patterns of each of the antenna types were recorded on polar paper. The patterns to be measured and the location for each antenna were determined from the operational requirements. The requirements for each antenna are given in Table 1.

The model antennas were scaled as accurately as possible from the drawings available of the full scale antennas. The model antennas were tested on flat ground planes to ensure correspondence with patterns expected from the full scale antennas. Ideally a comparison of the model measurements over a ground plane with full scale patterns over a ground plane should be made. However, the study was attempting only to determine the relative antenna coverage when the same antenna was located in different positions on the aircraft. Therefore the fidelity of pattern replication for the model antennas was considered adequate.

3. RESULTS

3.1 COMPUTER PREDICTION OF ANTENNA TO ANTENNA COUPLING AND EMI

The locations of the new antennas were varied to determine the effect on interference margins. Their movement was restricted by operational considerations. The possible combination of new antenna locations could be assessed in a series of four trials. The antenna locations for each trial are given in Table 2.

Potential interference cases are listed in Table 3. It gives the EMI margin for each combination of Rx and Tx showing interference margins and the maximum reduction in EM which can be achieved by antenna placement. For each interference pair listed in Table 3 a detailed analysis of frequencies is given in Table 4. Table 4 gives the frequency range of the transmitter causing interference, the harmonic of the transmitter, the transmitter and receiver frequencies at which the maximum EMI would be observed, the frequency range of the receiver over which interference would occur, and the type of receiver response (i.e.: fundamental, image or spurious).

Several more potential EMI problems were identified by the program than are listed since worst case modelling of the input data results in more predicted interference than would actually occur. Consequently, further analysis of the predicted interference resulted in the elimination of several predicted EMI cases. Those rejected included situations where coincidence frequencies would not be assigned, where the EMI margin was less than zero and in some cases where the predicted frequency range overlapped the assumed skirt of the band. In the latter situation it was found that the MILSTD assumed skirt widths were wider than those given in the equipment characteristics.

Table 3 shows that in general the interference caused by or experienced by the new equipment can be reduced only small amounts by moving antennas. Antenna placement will not eliminate potential interference in the cases studied. Therefore antenna placement is determined largely by antenna performance, i.e. the location giving the optimum antenna pattern to suit the requirements of that subsystem will be chosen.

Other means of achieving system compatibility such as frequency management, time sharing, filtering, etc., must be used. Frequency management means that a simultaneous transmission and reception at a specific frequency is prevented by proper frequency assignment. Frequency management must take into account transmitter harmonics and receiver spurious responses as well as fundamental frequencies.

3.2 ANTENNA MODELLING

Each of the new antennas, VHFFM, VOR/LOC, Glide Slope, Marker Beacon were tested in more than one location in order to determine the optimum pattern coverage. Table 5 gives the WL, BL and FS for the positiond numbers referenced below. Table 6 is an index of the polar patterns, for all the antennas modelled. Each plot gives the relative antenna coverage on a db scale. Bottom and side views of the Tracker are shown in Figures 7 and 8 with the existing antennas noted. The VOR LOC, VHFAM and Glide Slope antennas were tried in more than one form. The primary VOR LOC antenna was the model of the Collins 837 B-1A which is made up of a pair of sleeve monopoles fed out of phase to form a sleeve dipole. This antenna was mounted in three different configurations. The standard mountings at position 11 had the base of the antenna at the leading edge of the vertical tail with the tails of quarter wave whips trailing. Plots 37 to 42 show the polar plots of the principal polarizations. Mounted at position #11 the base of the whips were at the leading edge of the vertical stabilizer while the whips extended forward of the vertical edge of the stabilizer. Plots 43 to 48 give the patterns for this configuration. In the third configuration at position #13 the base of the whips were just ahead of the first hinge with the body of the whips projecting forward. Patterns are given in plots 25 to 30. The other form of the VOR/LOC modelled was the Bendix Towel Rack Antenna located at position #11. This antenna is made up of a pair of current feed loops which are fed with phases 0° and 180°. It was used on the "COD"* version of the Tracker. Patterns are given in plots 31 to 36. The Collins 137 X -1 Dual VOR/LOC and VHF communications antenna (ram's horn) was modelled at position #13 on top of the fuselage behind the Tacan antenna.

The Collins 37P-4 Glide Slope antenna is a stub-folded-dipole with two inputs fed 180° out of phase. Patterns for the model of this antenna were taken at position #5 above the windscreen and #6 on the nose. Patterns are given in plots 1 to 6 and 7 to 12 respectively.

The Collins 37 X 2 Marker Beacon antenna was modelled at position #5,7,9 and 10. It is a small current loop antenna about 1/8 of a wavelength long, polarized along the longitudinal axis of the aircraft. Patterns taken for this antenna at position #10 are given in plots 73 to 78.

The Collins 37R-5, VHF antenna for AM and FM communications are stub monopole antennas. Patterns of the AM antenna were taken at position #'s 1,2,3 and 4. The FM antenna was positioned on the bottom of the aircraft at the two positions formerly used for communications on the "COD"* aircraft; position #'s 3 and 4. Patterns for the FM antenna model are shown in plots 55 to 66. The AM antenna model patterns are given in plots 13 to 24 for the two top positions and plots 49 to 72 for the two bottom positions.

3.3 ERROR ANALYSIS

As indicated in the introduction the EMI prediction program should only be used as an indication of degree of interference. The antenna to antenna coupling routines used by the program have undergone restricted validation tests. An average error of 2 db can be expected for isolation between 30 and 40 db and 17 db error for 40 to 60 db isolation in the frequency range 225 to 800 MHz. Errors could be greater for the VHF range. (Ref. 5) Lack of specific measured data for each equipment also leads to additional uncertainty in the computed EMI levels.

Consideration was given to possible errors in the antenna pattern measurements due to the model support stand. Patterns were repeated with additional parts similar to those of the support structure. No difference in the pattern was observed. The yaw plane pattern had a maximum angular error of 2.5° due to chain looseness. Angular error in the other planes was negligible. Error in the relative gain of the antenna patterns was estimated to be 1 db.

* "Carrier On Delivery"

4. DISCUSSION AND CONCLUSIONS

A discussion of the findings of the EMI study and pattern measurement study for each new subsystem is given below. A summary is given in Table 7.

4.1 NEW SYSTEM INSTALLATION

4.1.1 APS 504 (radar)

No appreciable interference is predicted. Potential interference sources operate at frequencies well below the radar frequency. The existing antenna is to be used.

4.1.2 ARN 509 (Omega)

There is no predicted interference into this system. No antenna patterns were measured since the frequency was below the cut-off of the modelling facility. The location of the new antenna is to be obtained from the manufacturer.

4.1.3 ARC 504 (Tacan)

The existing Tacan antennas are to be used. The computer program predicted interference from the IFF and UHF (third harmonic) transmitters. Closer examination of the Tacan receive channel frequencies showed that there was no direct coincidence between the IFF transmitter (1090 MHz) and a Tacan receive channel. Broadband interference due to the pulsed nature of the IFF output could be eliminated only by blanking. Frequency management would be required to avoid interference from the third harmonic of the UHF.

4.1.4 APX 77 (IFF)

Interference is predicted from the Tacan and UHF (third harmonic) transmitters. Closer examination of the frequencies of operation of the Tacan and IFF show that only channel 6 of the Tacan will coincide directly with the 1030 MHz receive frequency of the IFF. By avoiding transmitting on Channel 6 this possible interference will not occur. Interference due to non coincident Tacan transmissions would require supression of the interference source. The other potential interference source is the UHF third harmonic. Although the IFF responds only to coded pulses with specified pulse widths and spacings its sensitivity can be degraded by a CW signal. Frequency management would prevent UHF transmission on the IFF receive frequency. The IFF system will also use the existing antenna.

4.1.5 ARCS 511V (VHFAM)

Several EMI cases were predicted by the program. In all cases the reduction in the EMI margin (EM) was less than 4 db as a result of changing the antenna position. The most serious sources of potential interference for the VHFAM receiver are the fourth and fifth harmonics of the HF. Since antenna placement cannot eliminate the interference possibility it is necessary to use frequency management techniques to avoid coincidence or filter the HF output. Additional interference from the fundamental of the UHF into spurious responses of the VHFAM receiver are predicted. Additional isolation of 35 dB is required to eliminate this potential problem. This is not available within the confines of the aircraft. Testing should be carried out to determine the extent of interference. If severe enough, frequency management would again be required. The fundamental of the VHFFM transmitter is predicted to coincide with the image response of the VHFAM receiver resulting in interference of the same magnitude as from the UHF. The same evaluation would be required to assess the severity. Specific interference frequencies are given in Table 4 for test purposes. Severe interference predicted in the ARA 25 from the VHFAM transmitter can be avoided by proper frequency selections.

Antenna patterns were made for four antenna locations, position #1,2,3,4 (Table 5). Inspection of the resulting antenna patterns showed #1 (above the cockpit) to give the most uniform pattern at and above the horizon. Plots 19,22, 23 show the principal plane patterns in the E_Θ, polarization made at mid band of the cockpit mounted antenna. Below the horizon the belly-mounted antennas performed better. Because the VHFAM will be used for long range communication with ground the top mounted at position #1 is recommended.

4.1.6 AR201 (VHFFM)

The only source predicted to interfere with the VHFFM is the fundamental of the UHF. It coincides with a receiver spurious response. Since the EMI margin is not high (~ 20dB), cable losses, plus additional spurious rejection above the 60 dB assumed, may reduce this potential source of EMI to a negligible level. If testing shows that this will be a problem, frequency management would be required.

As in the case of the VHFAM the VHFFM is shown to interfere with the ARA25. Transmission on the ARA25 receive frequency must be avoided.

VHFFM antenna patterns were made at position #3 and #4. The pattern obtained from the two positions were close to being equivalent, however, the horizontal plane pattern of the front position gave constant gain over a larger section of the pattern than that of the rear position. Plots 55, and 61 give the horizontal plane patterns for the two positions. The first choice for the VHFFM antenna is then position #3. Plots 58, and 60 give the E_Θ, pitch and roll patterns at position #3.

4.1.7 ARN508(ILS) VOR/LOC

Frequency coincidence was computed to occur between the VOR fundamental and the VHFAM transmitter and HF fourth harmonic and between VOR spurious responses and VHFAM and FM transmitters. Since the potential interferers are predominantly front mounted, the rear mounted VOR/LOC antenna is preferred from an EMI standpoint. However, this increased isolation is not sufficient to prevent interference in any of the above mentioned cases. Frequency management will be required. In practice the VOR is assigned frequencies below 116 MHz and the VHF above 116 MHz.

The five VOR/LOC antenna type-location combinations outlined in Section 3 were measured. The ram's horn antenna did not compare favourably with the other configurations, most likely because of the height of the tail mounted antennas. The principal plane patterns of the towel rack antenna were judged best. However, those of the whips in the standard configuration were not seriously different. The major difference was the higher cross polarization component observed in the whip patterns. This should not cause problems since the ground transmitter is horizontally polarized. All of the tail mounted VOR/LOC antenna exhibited a decrease in gain of about 6 db below the horizon at $\theta=95^{\circ}$ (Plots 28, 34, 39, 46). This would result in a decrease in the maximum range of operation. Considering the availability of antennas and the small difference in patterns, the whip antennas mounted in the standard configuration at position #11 are recommended. The patterns for position #11 are given in plots 37 to 42.

4.1.8 GLIDE SLOPE

Direct frequency coincidence is possible between the Glide Slope receiver and the VHF transmitters. VHF transmitters should avoid operation close (± 275 KHz) to the glide slope receive channel in the 329.3 MHz to 335 MHz range.

The antenna patterns indicate a preference for putting the antenna on the nose. Plots 3 and 7 give the pitch plane patterns of the windscreen antenna pattern below the horizon. However mechanical constraints precluded mounting the antenna on the nose. Consequently a systems analysis was carried out to assess the performance of the Glide Slope system with the antenna mounted above the windscreen. It was determined that pattern degradation below the horizon would not result in unacceptable system performance. This was decided on the basis of a comparison of calculated received signal at a distance of 10 nautical miles from the transmitter with the receiver sensitivity (10 μv) details of the calculation are given in Appendix 1. In addition, there was a question concerning possible degradation of system performance due to the high cross polarization component of the windscreen mounted antenna. Information obtained from DOT on measurement of ground transmitter emissions showed that negligible vertical component or transmitted. Therefore little effect on Glide Slope performance would be observed. Plots 1 and 6 give the spin and roll patterns for the windscreen mounted antenna.

4.1.7 MARKER BEACON

The only potential interference for the Marker Beacon is from the HF transmitter. Interference can be eliminated by avoiding third, fourth or fifth harmonics which fall within the 74.75 MHz to 75.25 MHz band of the Marker Beacon receiver. Alternatively, filtering of the HF output could be used to reduce output at 75 MHz.

Three Marker Beacon antenna positions were modelled (positions #7, #9, and #10). The antenna patterns were essentially the same. The three principal plane patterns of position #10 are given in Plots 73, 74, and 77. Since antenna placement cannot eliminate the potential EMI problem caused by the HF transmitter it is recommended that the antenna be placed at position #10. The Marker Beacon performed adequately with the antenna located in this position on the COD configuration of the Tracker.

4.2 CONCLUSIONS

Results of the Tracker antenna placement study have been presented. Polar antenna patterns for all the antenna locations tested were included. (Note 1). Possible interference situations were outlined and methods for their suppression were suggested. Specific frequencies and EMI were given which could be used in writing an EMC test plan for the refitment program.

Note 1: Rectilinear antenna patterns above and below the horizon are available

TABLE 1

ANTENNA REQUIREMENTS

ANTENNA FUNCTION	FREQUENCY	POLARIZATION	RADIATION PATTERN
VHF Airborne Communication	118 MHz to 156 MHz	Vertical with minimum horizontal	omnidirectional in azimuth, maximum null depth not to exceed 20 db.
Glide Path	329 MHz to 335 MHz	Horizontal with minimum reception of vertical polarization.	Shall receive horizontally-polarized signals when the aircraft is heading within 90^{o} of the direction of the transmitter and flying at any altitude between horizontal and 20 degree bank, glide or climb. Pattern in forward half of the horizontal plane shall be free from nulls.
Marker Beacon	75 MHz	parallel to fore and aft axis of aircraft.	To be without deep nulls so that maximum gain is downward from the aircraft and in a direction not more than 10 degrees from vertical.
VOR/LOC	108 MHz - 122 MHz	Horizontal	Must be omnidirectional and provide the required signal reception for localizer and omnidirectional use at any heading with respect to direction of signal source and at any attitude from horizontal to 20 degrees bank, glide or climb.

TABLE 1 CONT'D

ANTENNA FUNCTION	ANTENNA PATTERNS RECORDED
VHF Airborne Communication	Rectalinear plots: $\Theta = -30^o$ to $+30^o$ in 5^o increments $0^o < \phi < 360^o$ E_Θ and E_ϕ polarizations Polar plots: Yaw, Pitch, Roll E_Θ and E_ϕ polarization
Glide Path	Rectalinear plots: $\Theta = -30^o$ to $+30^o$ in 5^o increments $0^o < \phi < 360^o$ E_Θ and E_ϕ polarizations Polar plots: Yaw, Pitch, Roll E_Θ and E_ϕ polarization
Marker Beacon	Yaw, Pitch, Roll E_Θ and E_ϕ polarizations
VOR/LOC	Rectalinear plots: $\Theta = -30^o$ to $+30^o$ in 5^o increments $0^o < \phi < 360^o$ E_Θ and E_ϕ polarizations Polar plots: Yaw, Pitch, Roll E_Θ and E_ϕ polarizations

TABLE 2

ANTENNA LOCATIONS (BL,WL,FS) FOR TRIAL NO.

TRIAL NAME SUBSYSTEM/ANT HOME	1			2			3			4		
ARA25 - ANTDF	9.0	0.0	85.0	9.0	0.0	85.0	0.0	0.0	85.0	9.0	0.0	85.0
APN503 - ANTDOP	0.0	0.0	355.0	0.0	0.0	355.0	0.0	0.0	355.0	0.0	0.0	355.0
ARC505 - ANTHF	0.0	93.6	312.0	0.0	93.6	312.0	0.0	93.6	312.0	0.0	93.6	312.0
ARC27A - AUHF	0.0	186.2	445.4	0.0	186.2	445.4	0.0	186.2	445.4	0.0	186.2	445.4
ARN6/44 - AADF1	0.0	92.6	352.0	0.0	92.6	352.0	0.0	92.6	352.0	0.0	92.6	352.0
AADF2	0.0	85.0	230.0	0.0	85.0	230.0	0.0	85.0	230.0	0.0	85.0	230.0
APS504 - ARDR	0.0	0.0	274.0	0.0	0.0	274.0	0.0	0.0	274.0	0.0	0.0	274.0
APN22 - AALT	0.0	0.0	393.0	0.0	0.0	393.0	0.0	0.0	393.0	0.0	0.0	393.0
ARN504 - AITCN	0.0	87.9	85.0	0.0	87.9	85.0	0.0	87.9	85.0	0.0	87.9	85.0
A2TCN	0.0	0.0	479.1	0.0	0.0	479.1	0.0	0.0	479.1	0.0	0.0	479.1
APX77 - AIDFN	0.0	186.2	445.4	0.0	186.2	445.4	0.0	186.2	445.4	0.0	186.2	445.4
ARN508 - AVRLC (837B-1A)	0.0	157.0	430.0	0.0	87.9	60.0	0.0	87.9	110.0	0.0	157.0	430.0
ANTGS (37P-4)	0.0	72.0	37.0	0.0	43.5	0.0	0.0	43.5	0.0	0.0	43.5	0.0
AMKBK (37×-2)	0.0	0.0	330.0	0.0	0.0	510.0	0.0	0.0	150.0	0.0	0.0	359.0
ARC511V - AVHFAM (37-5)	0.0	87.9	110.0	0.0	87.9	110.0	0.0	87.9	183.0	0.0	87.9	183.0
AR201 - AVHFFM (37R-5)	10.0	0.0	29.5	10.0	0.0	29.5	10.0	0.0	29.5	16.5	0.0	53.0
ARN509 - AOMEG	0.0	0.0	168.0	0.0	0.0	168.0	0.0	0.0	168.0	0.0	0.0	168.0

TABLE 3

PREDICTED EMI MARGINS

RX	ARN504		APX77		ARC511V			AR201	ARN508/LOC			
TX	APX77	ARC27A	ARN504	ARC27A	ARC505	ARC27A	AR201	ARC27A	ARC511V	ARC505	AR201	ARC511V
TRIAL NO.												
1	104.5	28.1	185.1	146.5	59.9	31.9	32.4	19.8	112.6	64.0	43.2	50.3
2	104.5	28.1	185.1	146.5	59.9	32.9	32.4	19.8	128.9	58.5	42.5	66.6
3	104.5	28.1	185.1	146.5	63.8	34.8	31.8	19.8	125.6	60.4	42.3	63.3
4	104.5	28.1	185.1	146.5	63.8	34.8	33.1	21.0	114.7	64.0	44.1	52.4
Max decr. in EM due to Ant. Pos'n change (db)	0.0	0.0	0.0	0.0	3.9	2.9	1.3	1.2	16.3	5.5	1.8	16.3

TABLE 3 CONT'D

RX	ARN508GS	ARN508/MKBK	ARA25		ARC27A			ARN6/44	ARA25
TX	ARC27A	ARC505	ARC511V	AR201	ARC511V		AR201	ARC505	ARC505
TRIAL NO.									
1	87.3	30.2	123.4	143.9	41.5	38.0	30.3	165.1	65.2
2	86.5	27.8(3)	123.4	143.9	41.5	38.0	30.3	165.1	65.2
3	86.5	28.4	123.0	143.9	43.4	39.9	30.3	165.1	65.2
4	86.5	30.0	123.0	148.4	43.4	39.9	31.4	165.1	65.2
Max. decrease in EM due to Ant. Pos'n change (db)	0.8	2.4	0.4	4.5	1.9	1.9	1.1	-	-

TABLE 4

FREQUENCY RANGES OF POSSIBLE INTERFERERS

RX	ARN504		APX77		ARC511V			AR201	ARN508/LOC			
TX	APX77	ARC27A	ARN504	ARC27A	ARC505	ARC27A	AR201	ARC27A	ARC511V	ARC505	AR201	ARC511V
Transmitter Frequency Range (MHz) (Note 1)	1047.0 to 1133.0	277.2 to 454.1	975.0 to 1085.0	325.0 to 361.66	29.0 to 34.0	194.5 to 322.5	156.0 to 157.5	336.5 to 338.4	100.3 to 133.9	23.4 to 33.5	156.0 to 157.45	130.5 to 172.6
Transmitter Harmonic	1	3	1	3	4	1	1	1	1	4	1	1
Transmit Frequency for maximum EMI(MHz)	1087.0	320.7	1015.0	383.3	29.0	225.0	156.03	336.6	116.0	27.0	156.25	150.90
Frequency of maximum EMI (MHz)	1087.0	962.0	1015.0	1015.0	116.0	142.5	116.03	156.1	116.0	108.0	89.3	86.45
Receiver Frequency Range (MHz) (Note 1)	1047.0 to 1133.0	831.6 to 1362.3	975.0 to 1085.0	975.0 to 1085.0	116.0 to 136.3	127.0 to 152.0	116.0 to 117.5	156.0 to 157.0	100.3 to 133.9	93.4 to 133.9	89.3 to 89.75	76.25 to 97.3
Order of Frequency Response (Note 2)	F	F	F	F	F	S	I	S	F	F	S	S

TABLE 4 CONT'D

FREQUENCY RANGES OF POSSIBLE INTERFERERS

RX	ARN508/GS	ARN508/MKBK	ARA25			ARC27A		ARN6/44
TX	ARC27A	ARC508	ARC511V	AR201	ARC505	ARC511V	AR201	ARC505
Transmitter Frequency Range (MHz) Note 1	329.1 to 335.2	24.9 to 25.1	100.3 to 172.6	156.0 to 157.6	20.0 to 34.0	112.4 to 172.5	156.0 to 157.5	1.729 to 3.974
Transmitter Harmonic	1	3	1	1	5	2	2	1
Transmit Frequency for maximum EMI (MHz)	329.2	25.0	116.0	156.0	23.2	116.0	156.025	2.0
Receiver Frequency of Maximum EMI (MHz)	329.2	75.0	116.0	156.0	116.0	232.0	312.05	2.0
Receiver Frequency of Range (MHz) Note 1	329.1 to 335.2	74.6 to 75.4	100.3 to 172.6	156.0 to 157.5	100.3 to 170.3	224.0 to 345.1	312.0 to 314.9	1.729 to 3.974
Order of Frequency Response	F	F	F	F	F	F	F	F

TABLE 5 ANTENNA LOCATIONS (BL,WL,FS)

Position # \ BL,WL,FS	BL	WL	FS
1	0.0	87.9	110.0
2	0.0	87.9	183.0
3	10.0	0.0	29.5
4	16.0	0.0	53.0
5	0.0	72.0	43.5
6	0.0	37.0	0.0
7	0.0	0.0	235.0
8	0.0	0.0	510.0
9	0.0	0.0	150.0
10	0.0	0.0	375.0
11	0.0	157.0	430.0
12	0.0	87.0	60.0
13	0.0	157.0	449.0

TABLE 6 INDEX TO POLAR PATTERNS

			PATTERN PLANE					
			YAW		PITCH		ROLL	
			POLARIZATION		POLARIZATION		POLARIZATION	
ANTENNA	POSITION NUMBER	LOCATION	E_θ	E_ϕ	E_θ	E_θ	E_θ	E_θ
Glide Slope	5	Windscreen	1	2	3	4	6	5
	6	Nose	11	12	7	8	10	9
VHF-AM	2	Top of Wing	14	13	16	15	17	18
	1	Top of Cabin	24	23	21	22	20	19
	3	Belly-Forward Cod Position	50	49	51	52	54	55
	4	Belly-Rear Cod Position	68	67	69	70		71
VOR/LOC	13	Whips: Base at Hinge Tails forward	26	25	28	27	29	30
	11	Whips: Base at Leading Tails forward	43	44	46	45	47	48
	11	Whips: Base at Leading Edge Tails to rear	37	38	39	40	41	42
	11	Towel Rack: Leading Edge and hinge	31	32	34	33	35	36
VHF-FM	3	Belly-Forward Cod Position	56	55	57	58	59	60
	4	Belly-Forward Cod Position	62	61	63	64	66	65
Marker Beacon	10	Belly	74	75	73	78	77	76

TABLE 7

SUMMARY

SYSTEM NAME	ORDER OF RESPONSE	POTENTIAL EMI FROM	EMI MARGIN (dB)	MAXIMUM EMI REDUCTION BY ANTENNA PLACEMENT (dB)	SUGGESTED EMI REDUCTION METHODS	RECOMMENDED ANTENNA LOCATION NOTE 1	PATTERN MEASUREMENT DISCUSSION
APS 504	-	-	-	-	-	Antenna existing	-
APN 509	-	-	-	-	-	Antenna location to be recommended by manufacturer	-
ARN 504	Fundamental	APX 77	104.5	-	Blank the transmitter. Filter VHF output, Frequency management	Antenna existing	-
	Fundamental	ARC 27A, 3rd harmonic	28.1	-			
APX 77	Fundamental	ARN 504	185.1	-	Blank the transmitter, Frequency management, Avoid transmitting 343.3 MHz	Antenna existing	-
	Fundamental	ARC 27A, 3rd harmonic	146.5	-			
ARC 511V	Fundamental	ARC 505, 4th and 5th harmonics	63.8	3.9	Filter HF output or Frequency management	Position #1 (see Table 1) above cockpit behind Tacan antenna	Patterns at and above horizon were best in this location Plots 19, 22,23.

TABLE 7 (CONT'D)

SYSTEM NAME	ORDER OF RESPONSE	POTENTIAL EMI FROM	EMI MARGIN (dB)	MAXIMUM EMI REDUCTION BY ANTENNA PLACEMENT (dB)	SUGGESTED EMI REDUCTION METHODS	RECOMMENDED ANTENNA LOCATION NOTE 1	PATTERN MEASUREMENT DISCUSSION
/VORLOC	Fundamental	ARC 505 4th harmonic	64.0	5.5	Filter HF output or frequency management.		
	Spurious	AR201	44.1	1.8	Frequency management or improve receiver selectivity		
	Spurious	ARC511V	66.6	16.3	Frequency management or improve receiver selectivity		
/Glide Slope	Fundamental	ARC 27A	87.3	0.8	UHF frequencies are not assigned between 329 MHz to 335 MHz. EMI not probable.	Position #6 (see Table 3) on the nose	Pattern of windscreen antenna showed rapid drop in gain below horizon, nose pattern good below horizon, also lower cross polarization component (see Plots 3,7, 10,11)
/Marker Beacon	Fundamental	ARC 505 3rd,4th,5th harmonics)	30.2	2.4	Filter HF output or frequency management	Position #10 on bottom between radar altimeter and doppler radar	Patterns obtained from positions #7, 9, 10 were all satisfactory (Plots 73,74,77)

Note 1: Recommended locations of new antenna are shown in Figure 22.

TABLE 7 (CONT'D)

SYSTEM NAME	ORDER OF RESPONSE	POTENTIAL EMI FROM	EMI MARGIN (dB)	MAXIMUM EMI REDUCTION BY ANTENNA PLACEMENT (dB)	SUGGESTED EMI REDUCTION METHODS	RECOMMENDED ANTENNA LOCATION NOTE 1	PATTERN MEASUREMENT DISCUSSION
ARC 511V	Spurious	ARC 27A	34.8	1.9	Frequency management or improve receiver selectivity		
	Image	AR 201	33.1	1.3	Frequency management or improve receiver selectivity		
AR 201	Spurious	ARC 27A	21.0	1.2	Frequency management. Improve receiver selectivity	Position #3 bottom of aircraft near nose, former antenna location closest to nose	Horizontal (spin) plane pattern was slightly better for position closest to nose(see Figs. 55,61,58,60)
ARN 508 /VORLOC	Fundamental	ARC 511V	128.9	16.3	VOR/LOC receive <116 MHz, VHF transmit >116 MHz EMI not probable	Position #11 whip antenna on vertical stabilizer close to meading edge and fiber glass fin cap.	Principle plane patterns of towel rack antenna (at position #11) were somewhat better than for whips. Whips better below horizon. Cross polarization was lower for towel rack antenna (Plots 31 to 42)

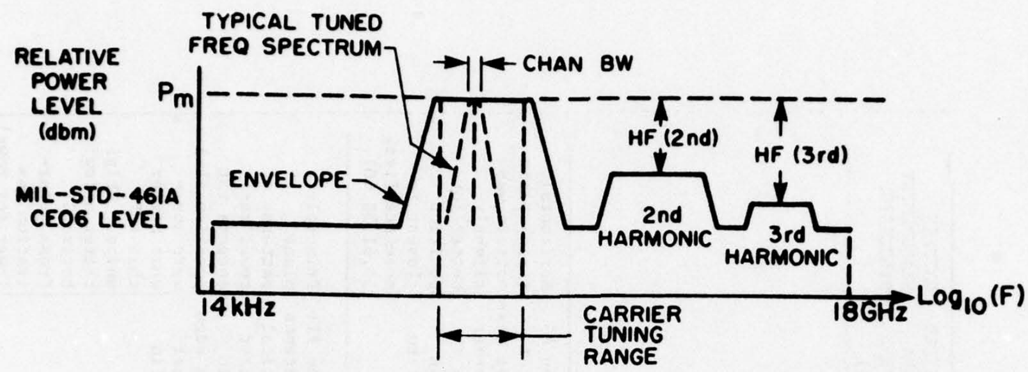


FIGURE 1 TRANSMITTER EMISSION SPECTRUM

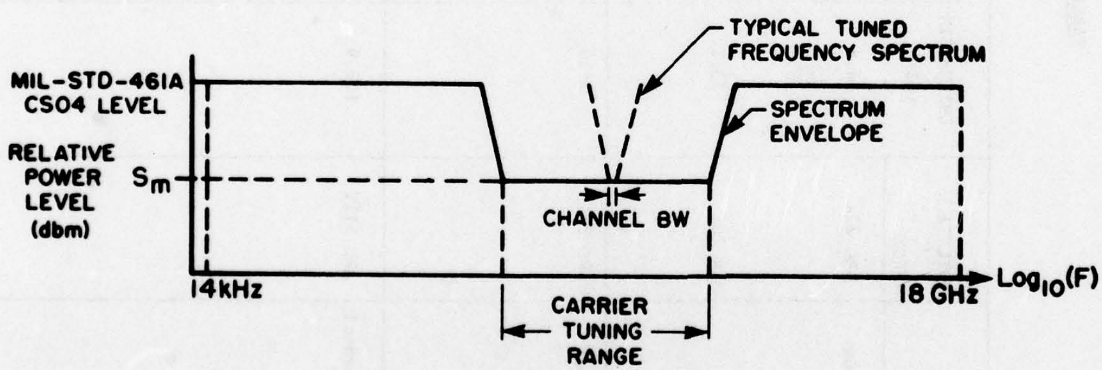


FIGURE 2 RECEIVER SUSCEPTIBILITY SPECTRUM

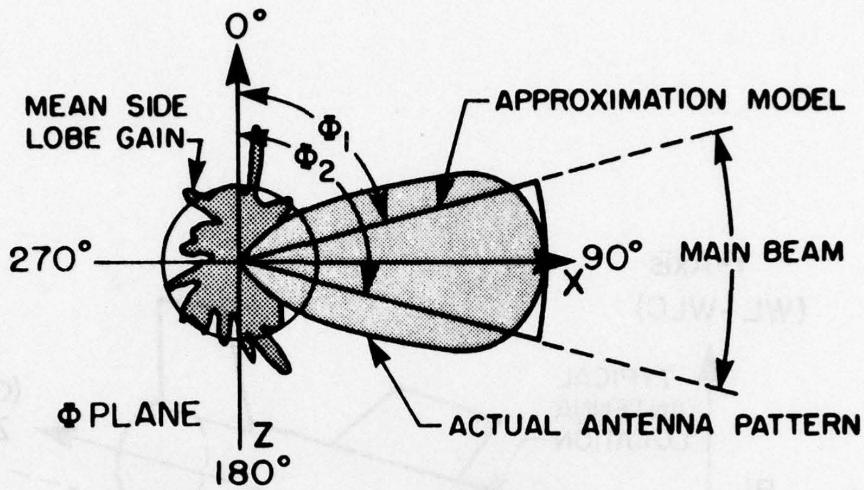


FIGURE 3(a) TWO- LEVEL APPROXIMATION MODEL FOR DIRECTIONAL ANTENNAS

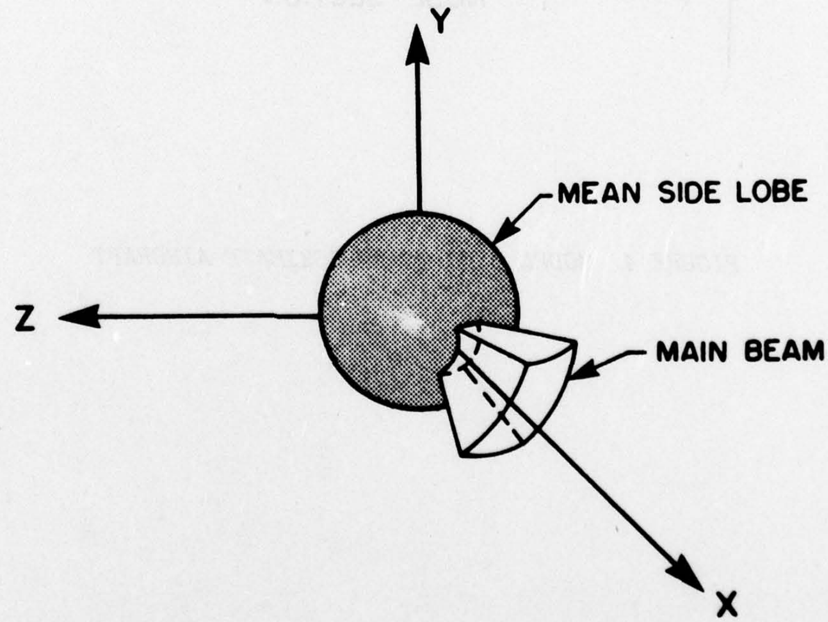


FIGURE 3(b) ANTENNA MODEL APPLIED TO TYPICAL RADAR ANTENNA

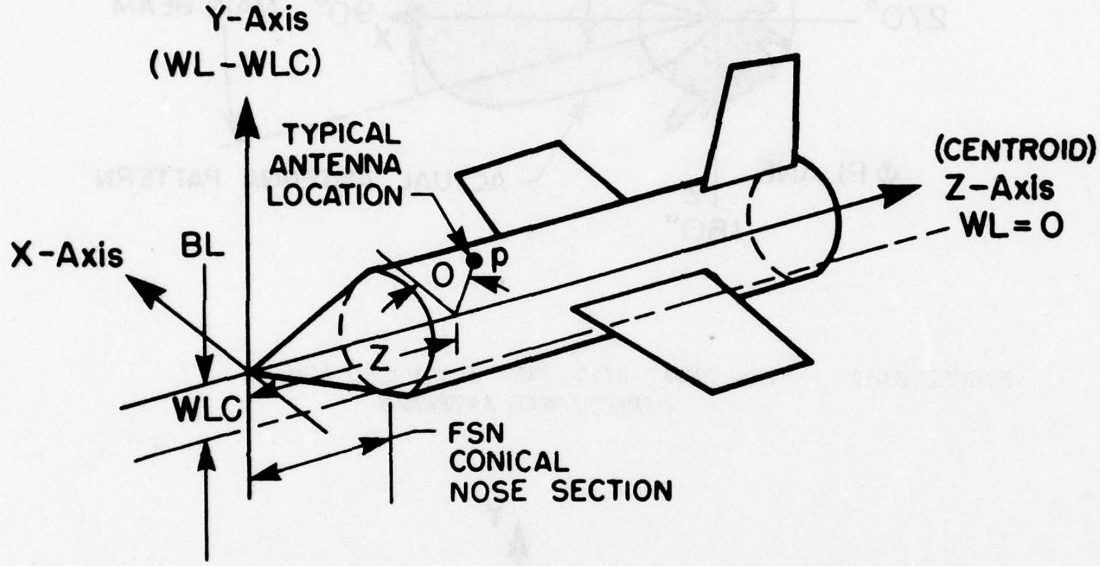


FIGURE 4 MODEL USED TO APPROXIMATE AIRCRAFT

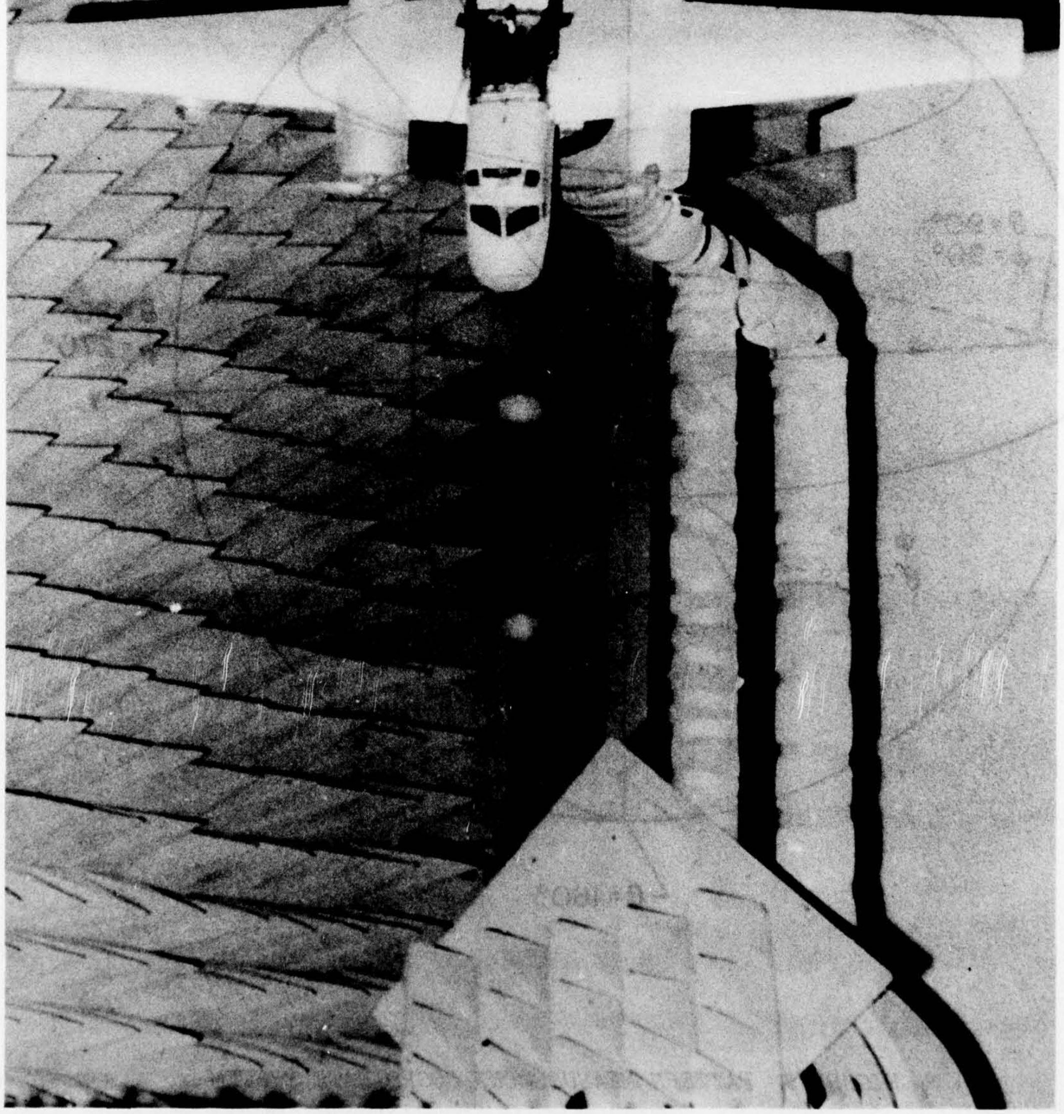


FIGURE 5 MODEL OF TRACKER AIRCRAFT

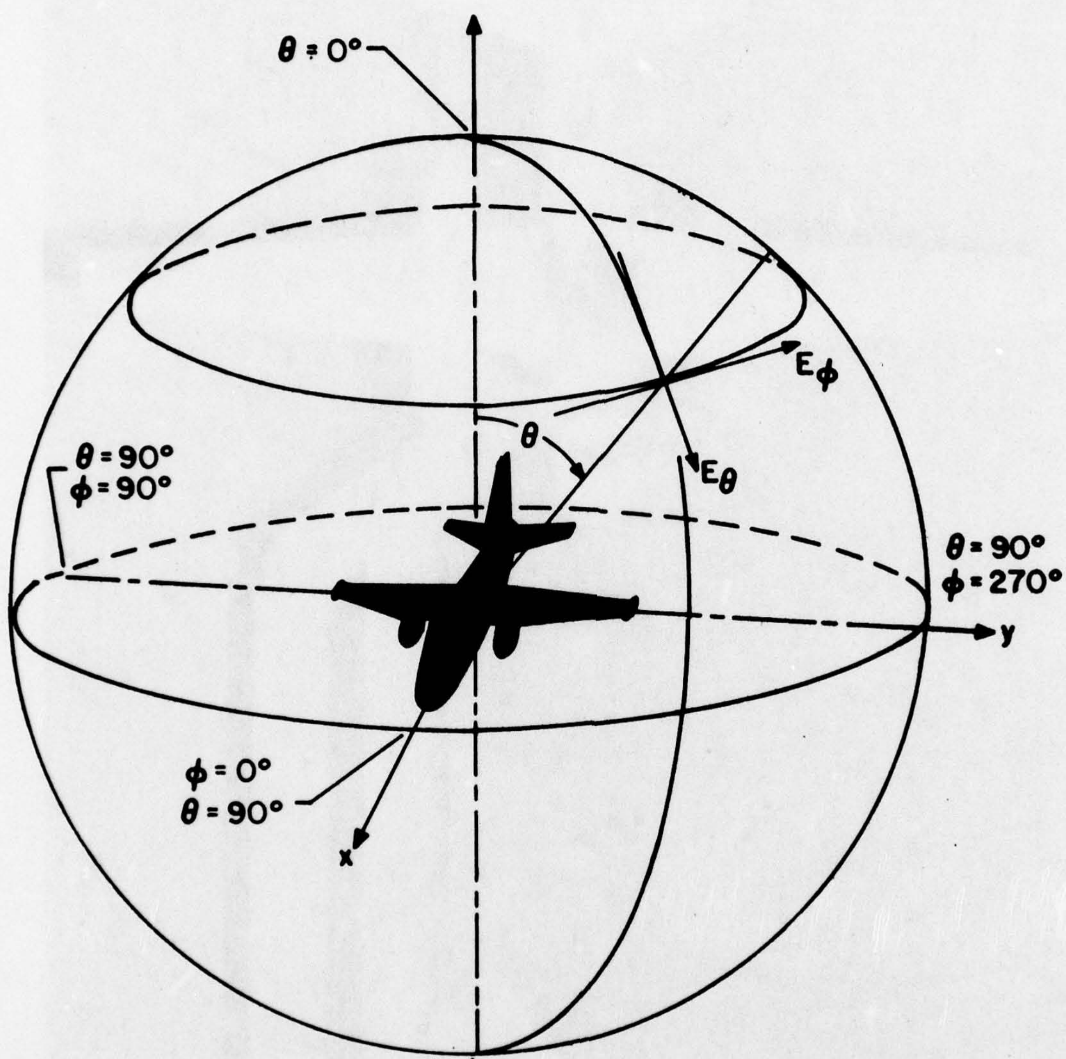


FIGURE 6 PATTERN MEASUREMENT COORDINATE SYSTEM

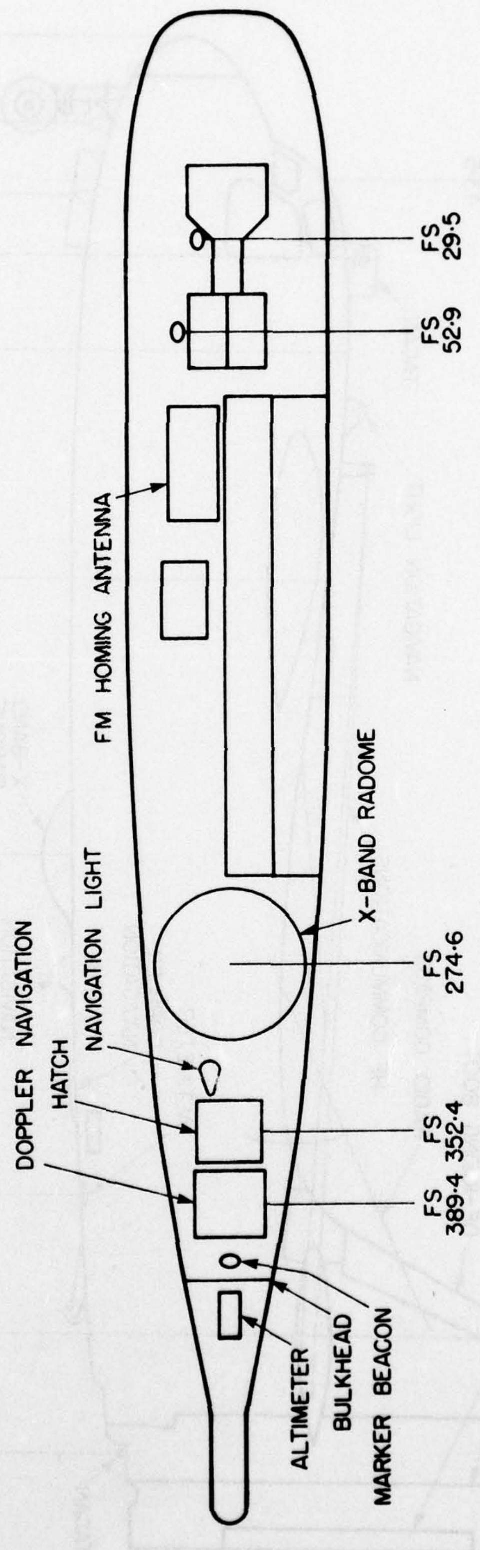


FIGURE 7 - TRACKER AIRCRAFT - BOTTOM VIEW

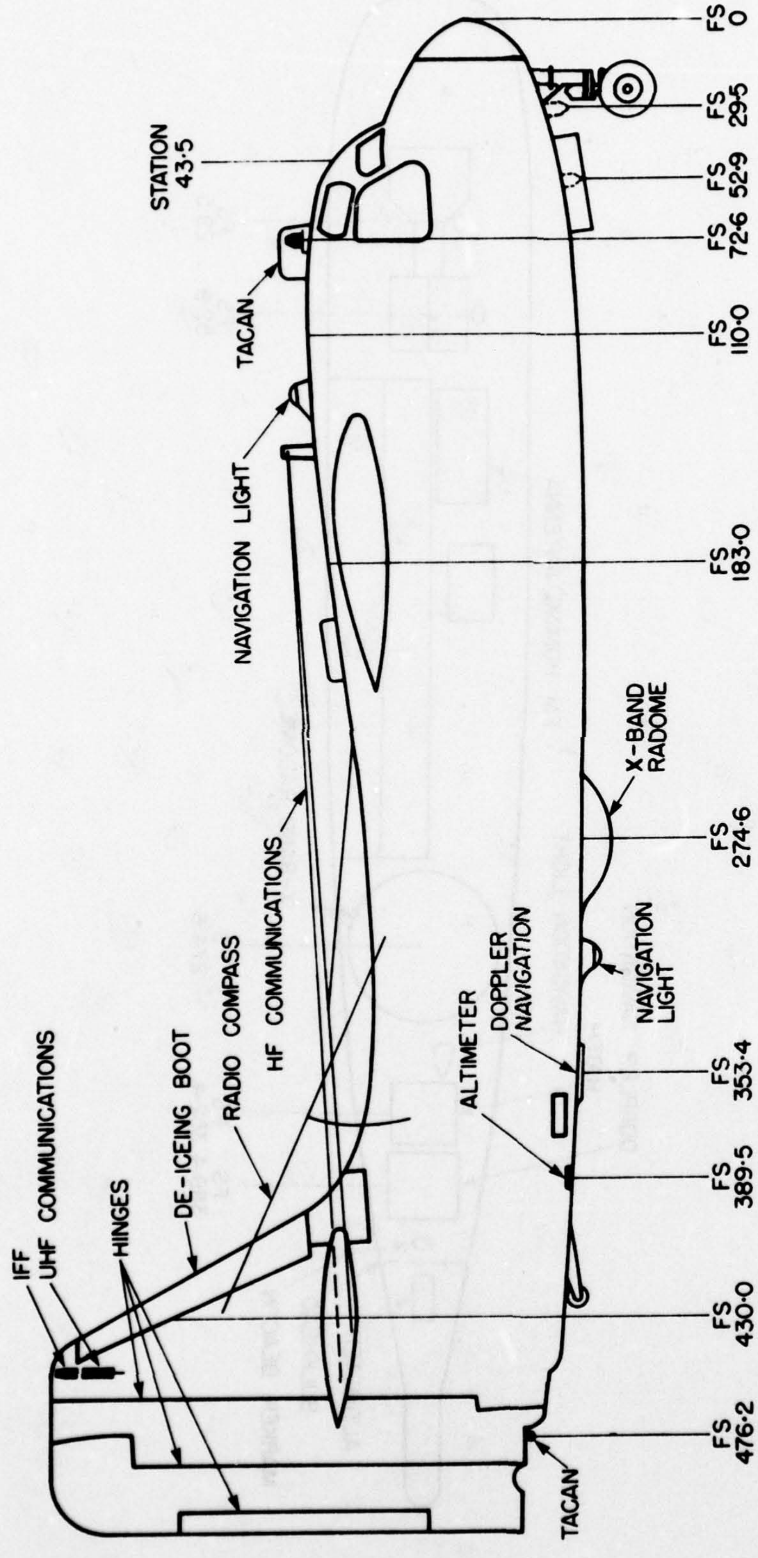
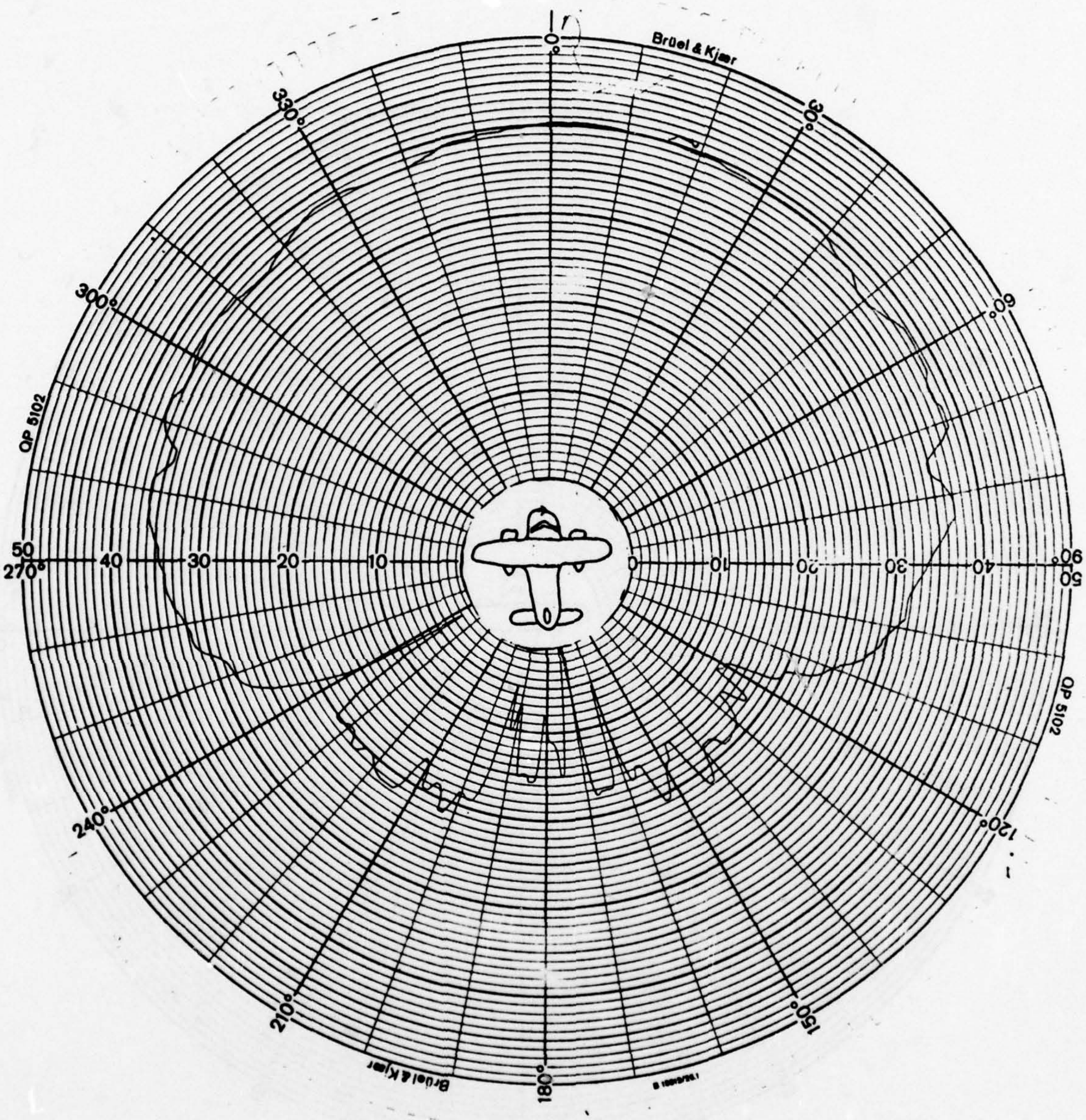


FIGURE 8 - TRACKER AIRCRAFT - SIDE VIEW



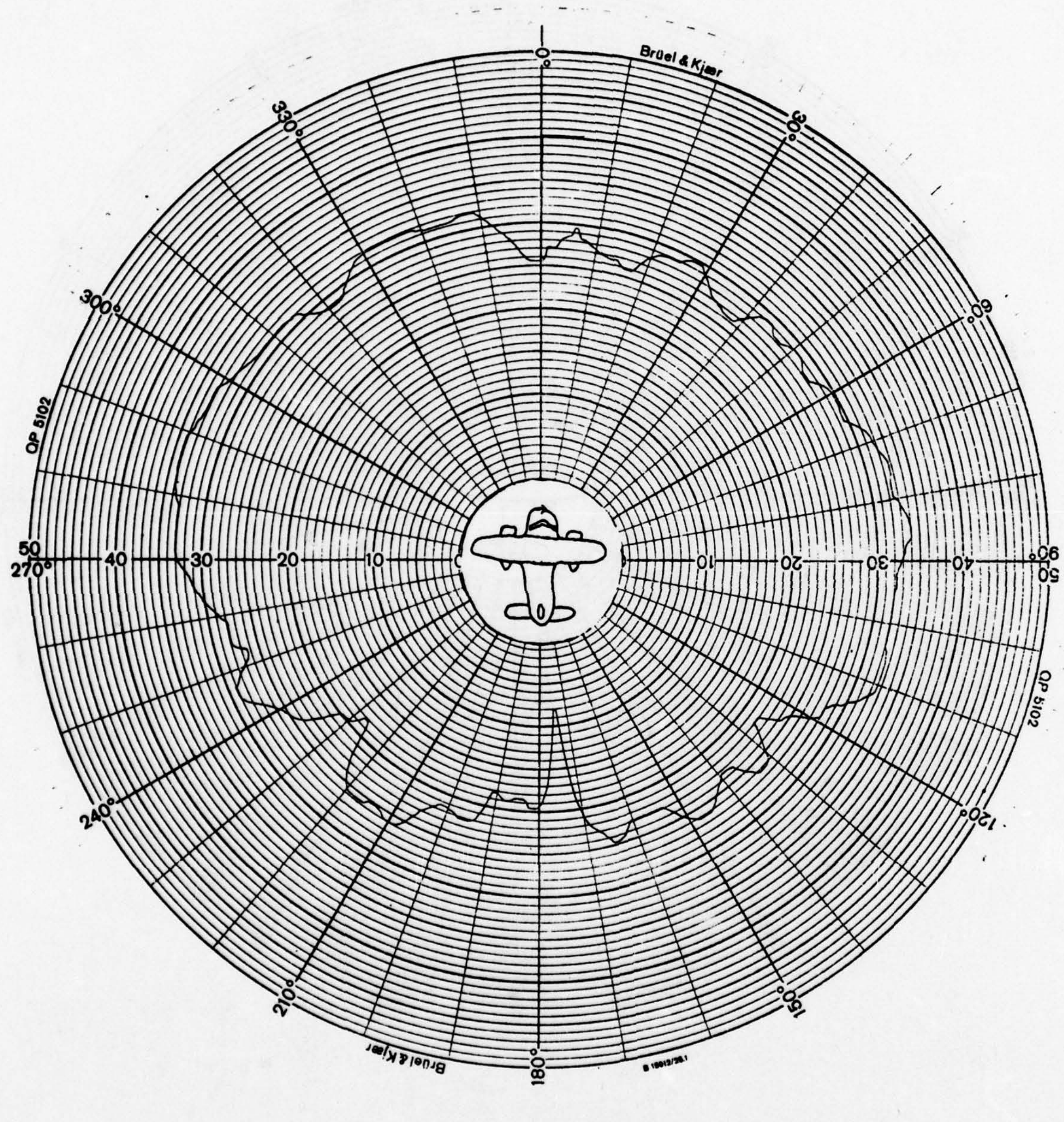
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)

PLOT NO. 1 *POLARIZATION* E_θ ___ E_ϕ ✓

PATTERN PLANE YAW ✓ *PITCH* ___ *ROLL* ___

ANTENNA TYPE GLIDE SLOPE

ANTENNA LOCATION TOP OF WINDSCREEN



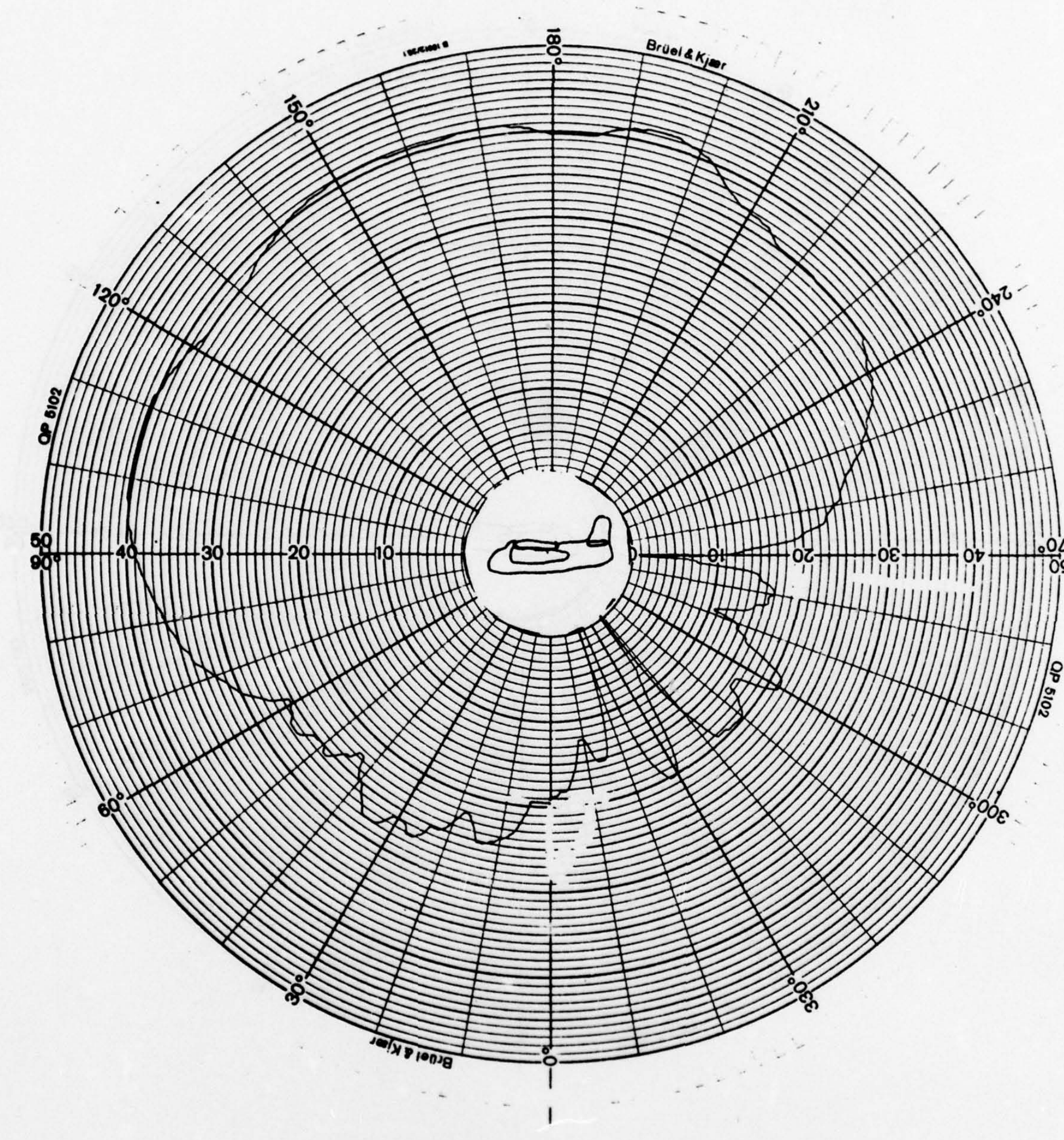
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)

PLOT NO. 2 *POLARIZATION* E_θ ✓ E_ϕ ____

PATTERN PLANE YAW ✓ *PITCH* ____ *ROLL* ____

ANTENNA TYPE GLIDE SLOPE

ANTENNA LOCATION TOP OF WINDSCREEN



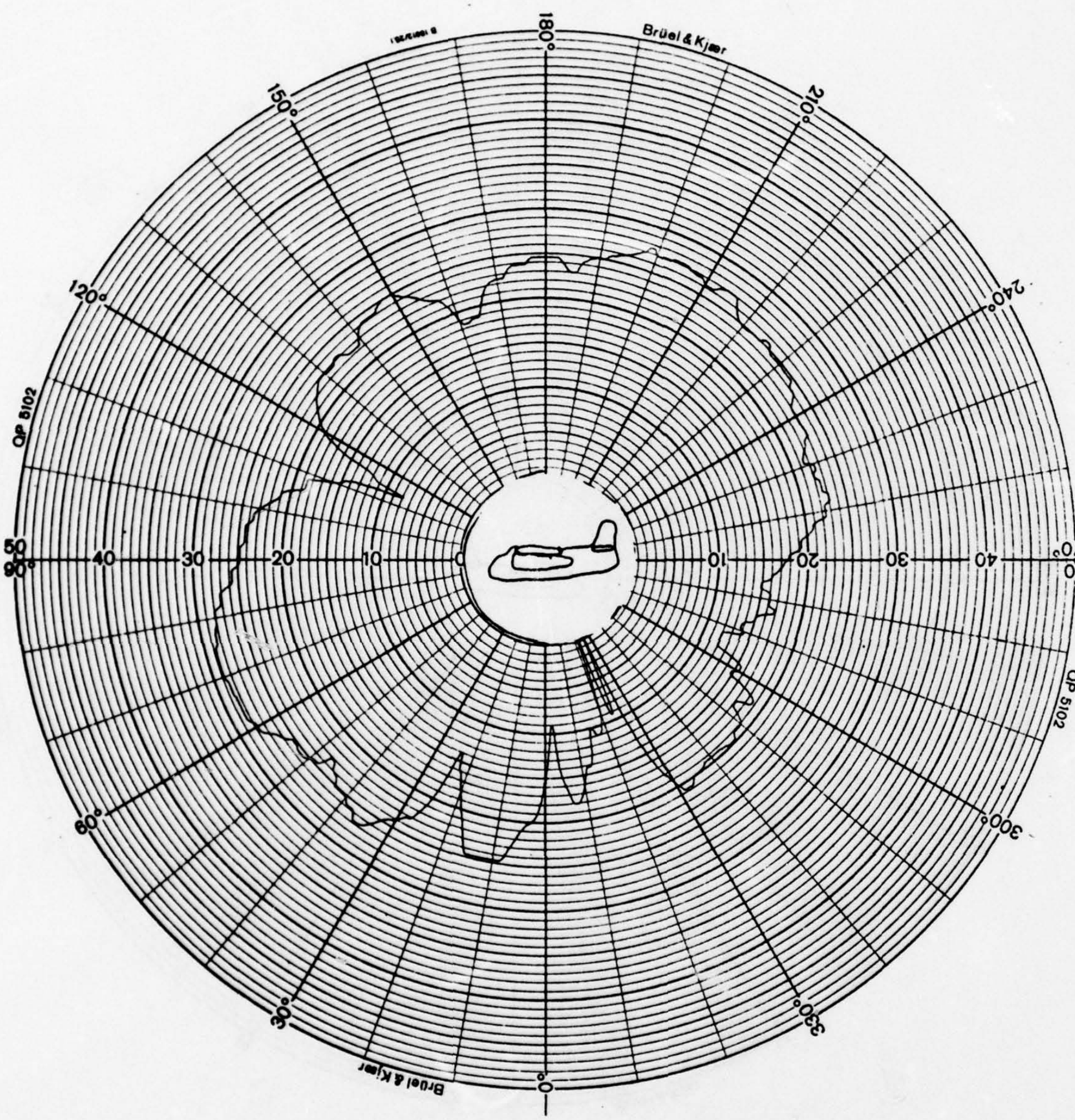
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)

PLOT NO. 3 *POLARIZATION* E_θ ___ E_ϕ ✓

PATTERN PLANE YAW ___ *PITCH* ✓ *ROLL* ___

ANTENNA TYPE GLIDE SLOPE

ANTENNA LOCATION TOP OF WINDSCREEN



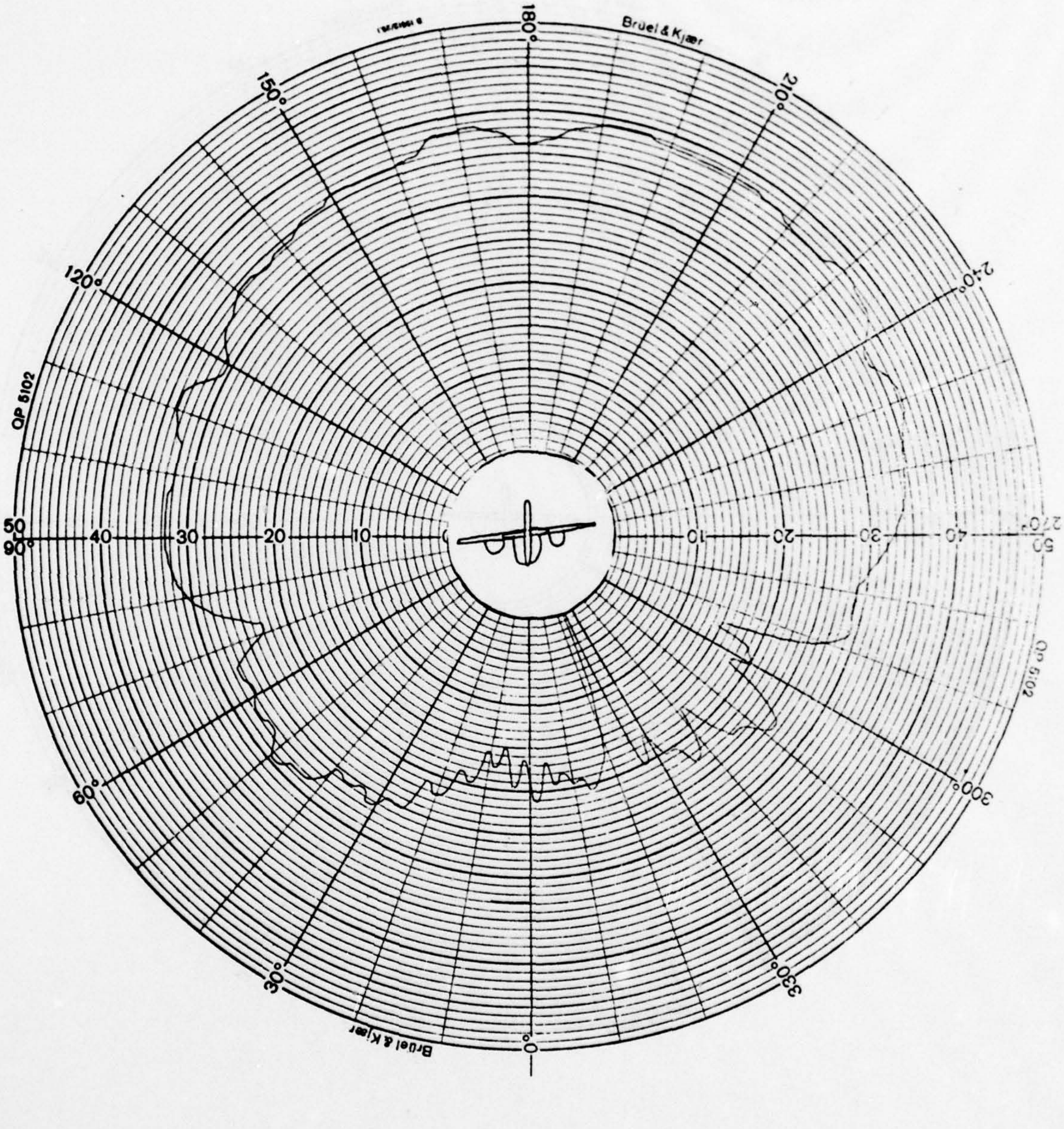
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)

PLOT NO. 4 *POLARIZATION* E_Θ ✓ E_ϕ ___

PATTERN PLANE *YAW* ___ *PITCH* ✓ *ROLL* ___

ANTENNA TYPE GLIDE SLOPE

ANTENNA LOCATION TOP OF WINDSCREEN



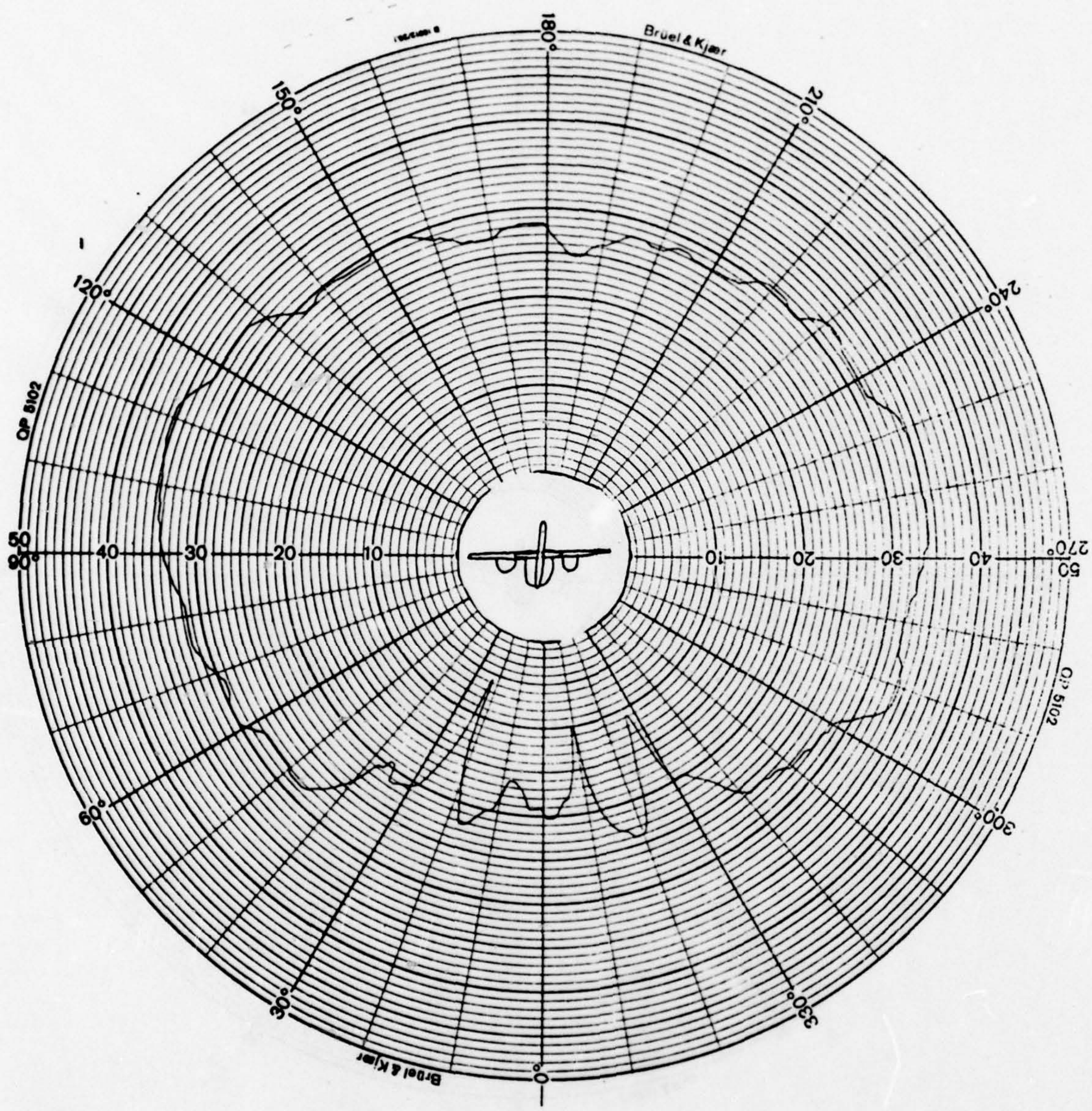
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)

PLOT NO. 5 *POLARIZATION* E_θ ____ E_ϕ ✓

PATTERN PLANE YAW ____ *PITCH* ____ *ROLL* ✓

ANTENNA TYPE GLIDE SLOPE

ANTENNA LOCATION TOP OF WINDSCREEN



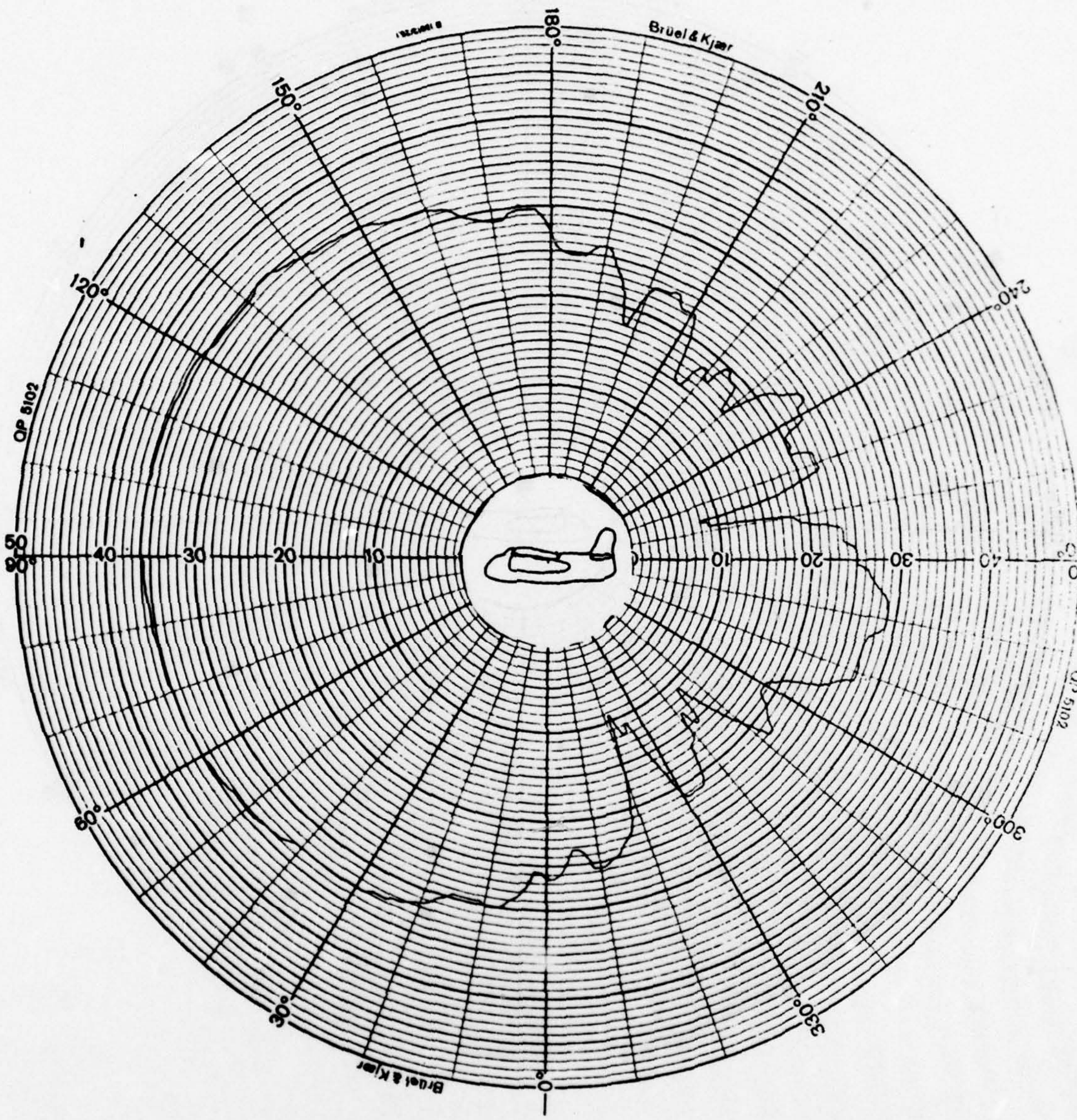
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)

PLOT NO. 6 *POLARIZATION* E_θ ____ E_ϕ ✓

PATTERN PLANE *YAW* ____ *PITCH* ____ *ROLL* ✓

ANTENNA TYPE GLIDE SLOPE

ANTENNA LOCATION TOP OF WINDSCREEN



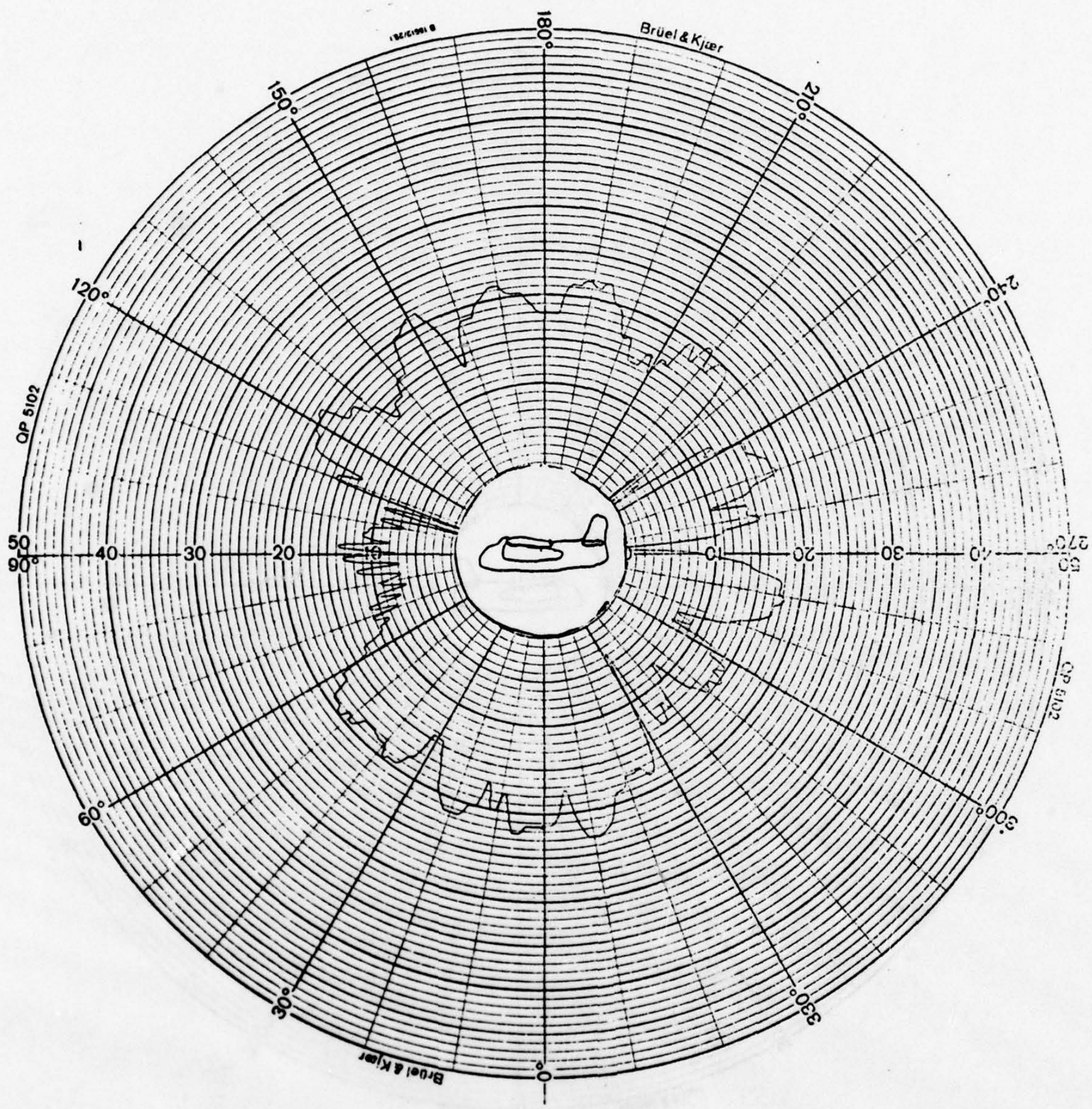
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)

PLOT NO. 7 *POLARIZATION* E_θ ___ E_ϕ ✓

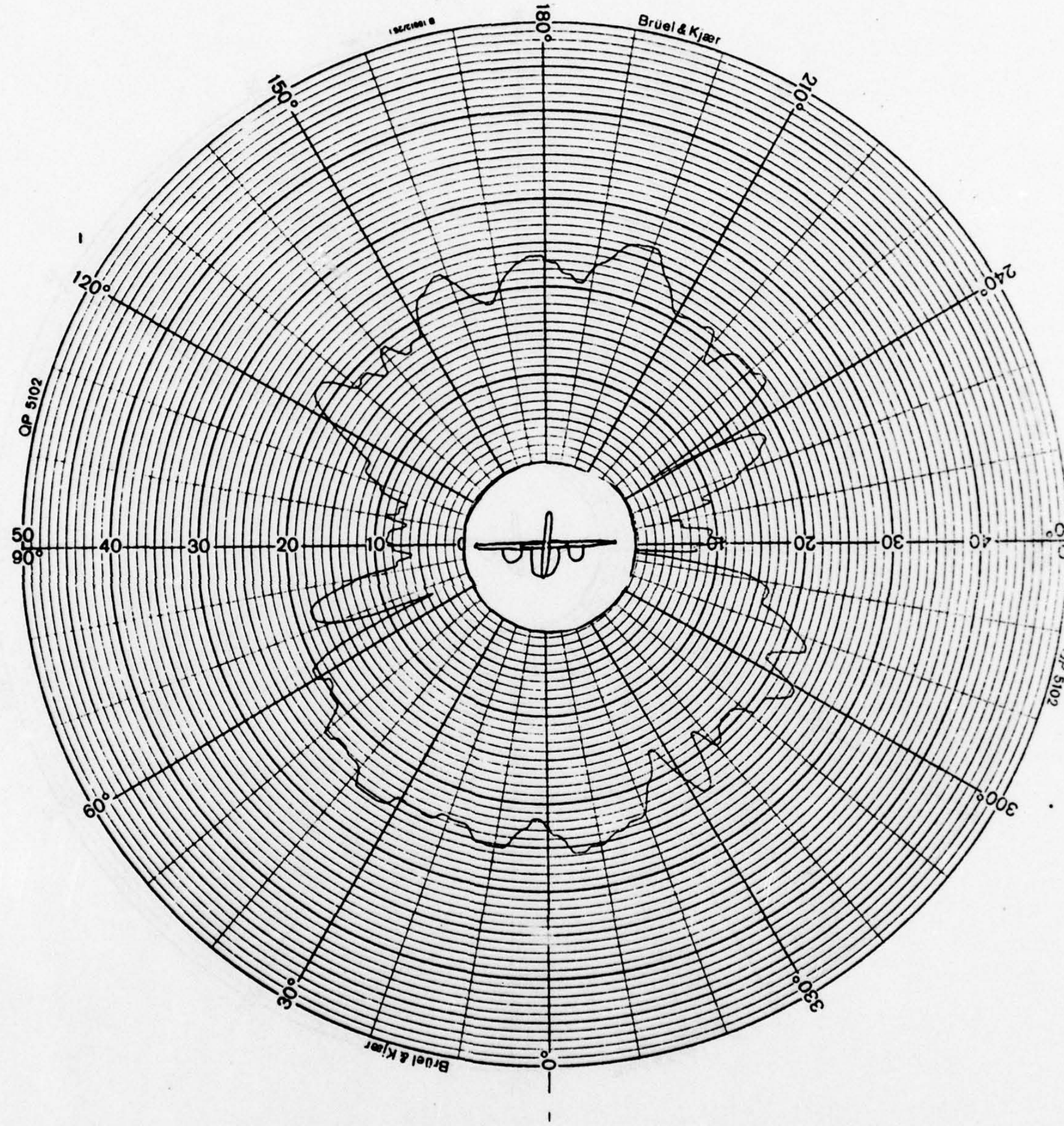
PATTERN PLANE YAW ___ *PITCH* ✓ *ROLL* ___

ANTENNA TYPE GLIDE SLOPE

ANTENNA LOCATION NOSE



TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 8 *POLARIZATION* E_θ ✓ E_ϕ ___
PATTERN PLANE YAW ___ *PITCH* ✓ *ROLL* ___
ANTENNA TYPE **GLIDE SLOPE**
ANTENNA LOCATION **NOSE**



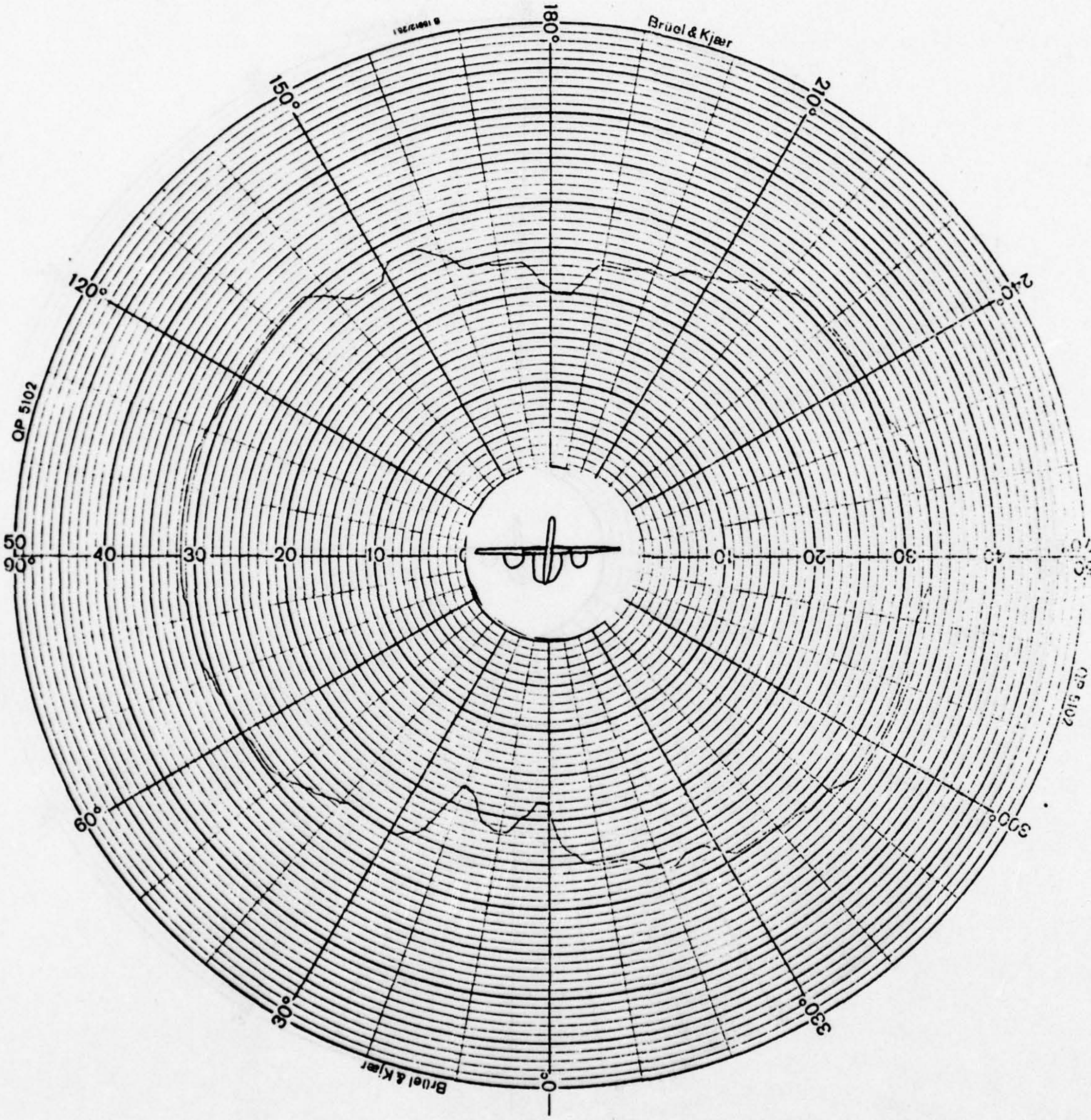
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)

PLOT NO. 9 *POLARIZATION* E_θ ✓ E_ϕ ____

PATTERN PLANE *YAW* ____ *PITCH* ____ *ROLL* ✓

ANTENNA TYPE GLIDE SLOPE

ANTENNA LOCATION NOSE



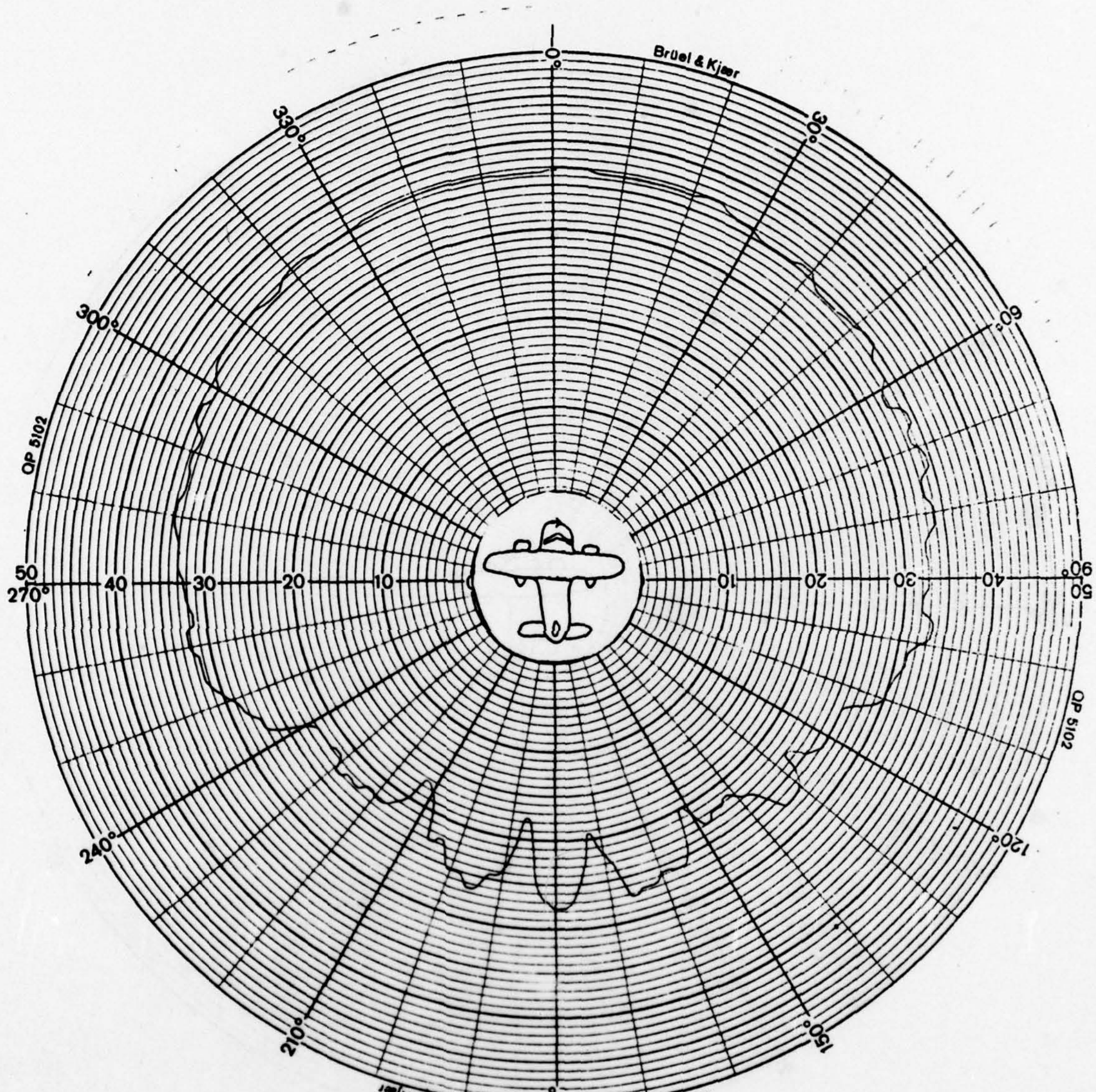
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)

PLOT NO. 10 *POLARIZATION* E_θ ____ E_ϕ ✓

PATTERN PLANE YAW ____ *PITCH* ____ *ROLL* ✓

ANTENNA TYPE **GLIDE SLOPE**

ANTENNA LOCATION **NOSE**



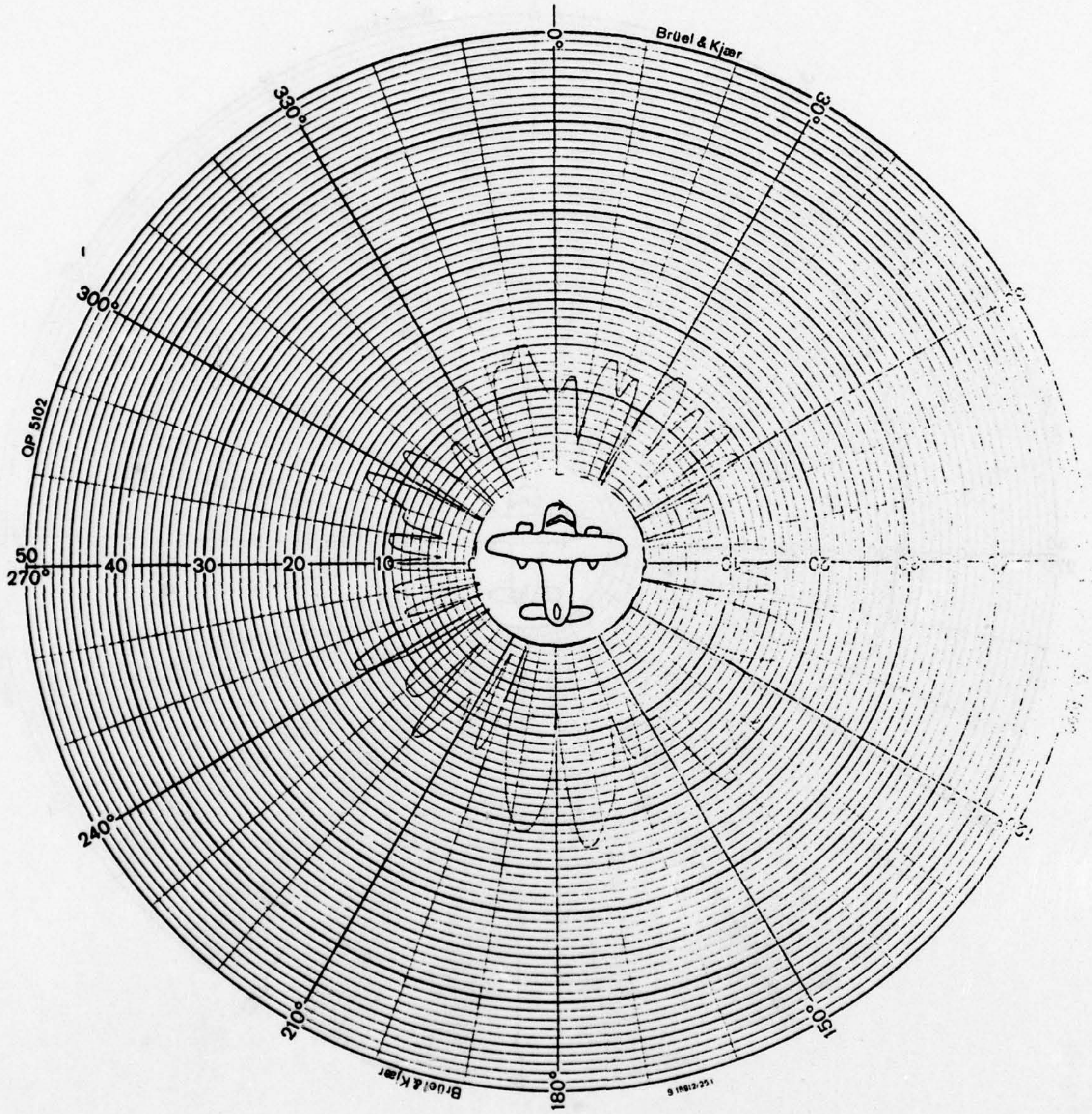
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)

PLOT NO. 11 *POLARIZATION* E_{θ} ___ E_{ϕ} ✓

PATTERN PLANE YAW ✓ *PITCH* ___ *ROLL* ___

ANTENNA TYPE GLIDE SLOPE

ANTENNA LOCATION NOSE



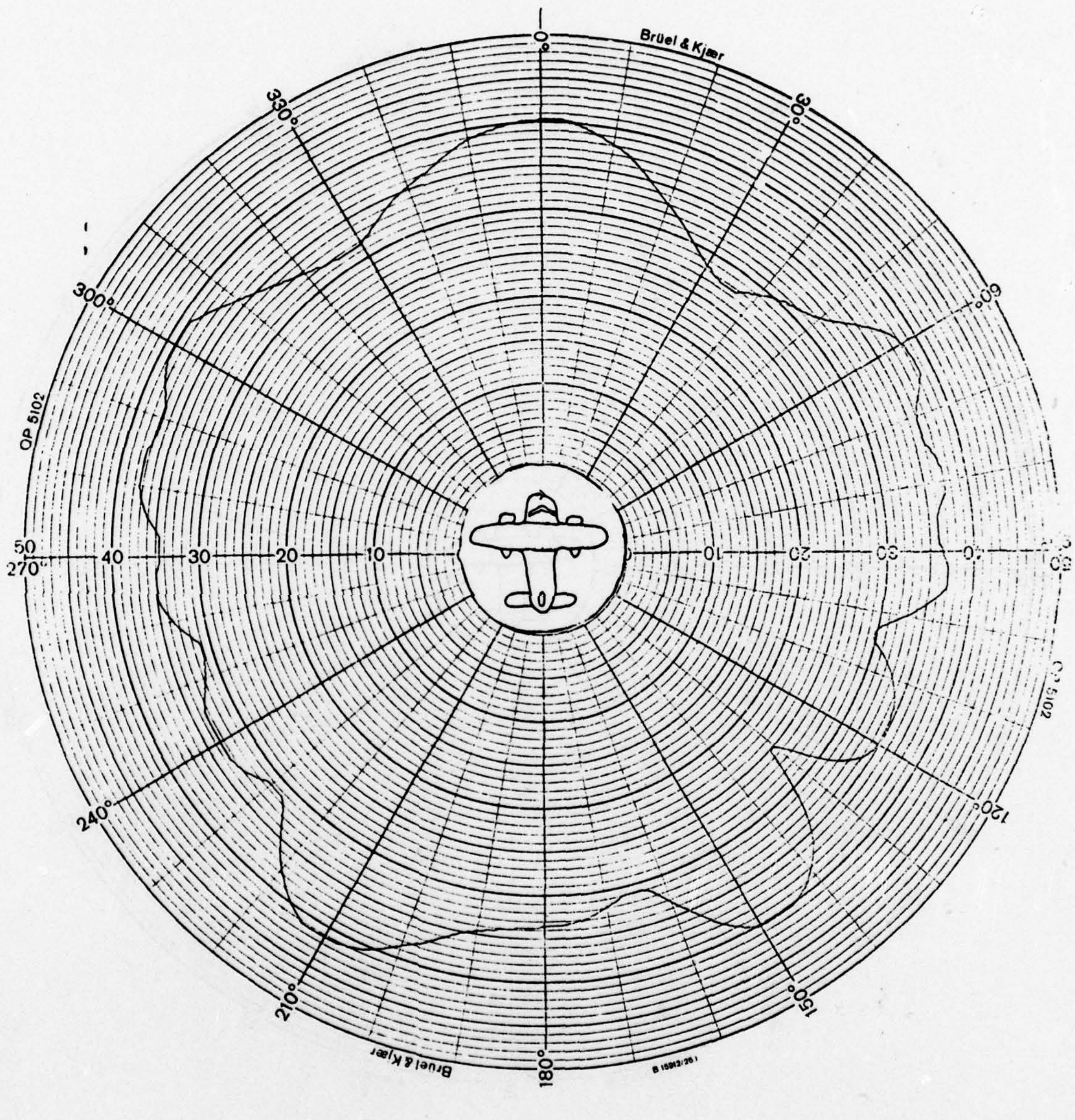
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)

PLOT NO. 12 *POLARIZATION* E_θ ✓ E_ϕ ____

PATTERN PLANE *YAW* ✓ *PITCH* ____ *ROLL* ____

ANTENNA TYPE GLIDE SLOPE

ANTENNA LOCATION NOSE



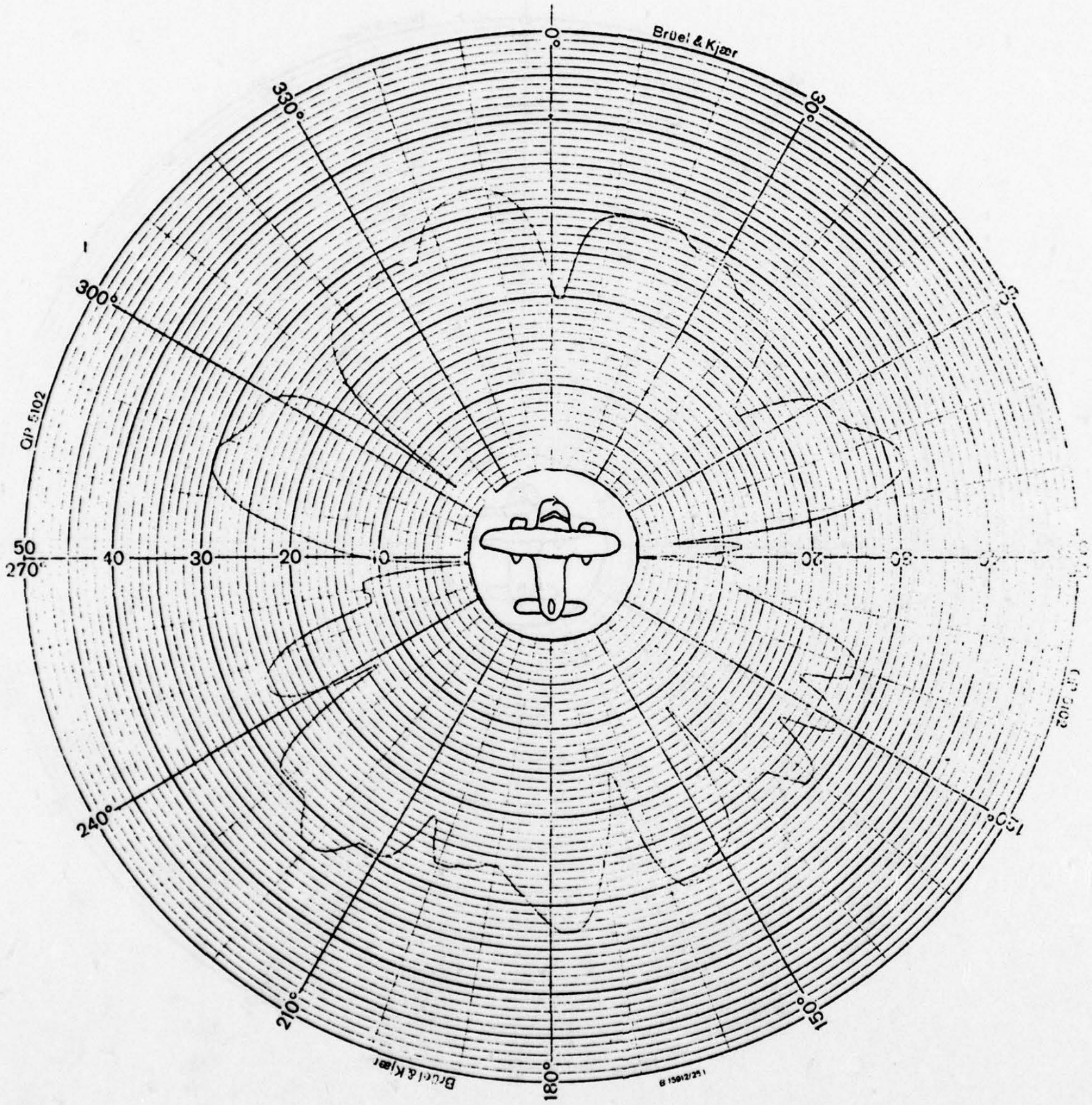
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)

PLOT NO. 13 *POLARIZATION* E_θ ✓ E_ϕ ____

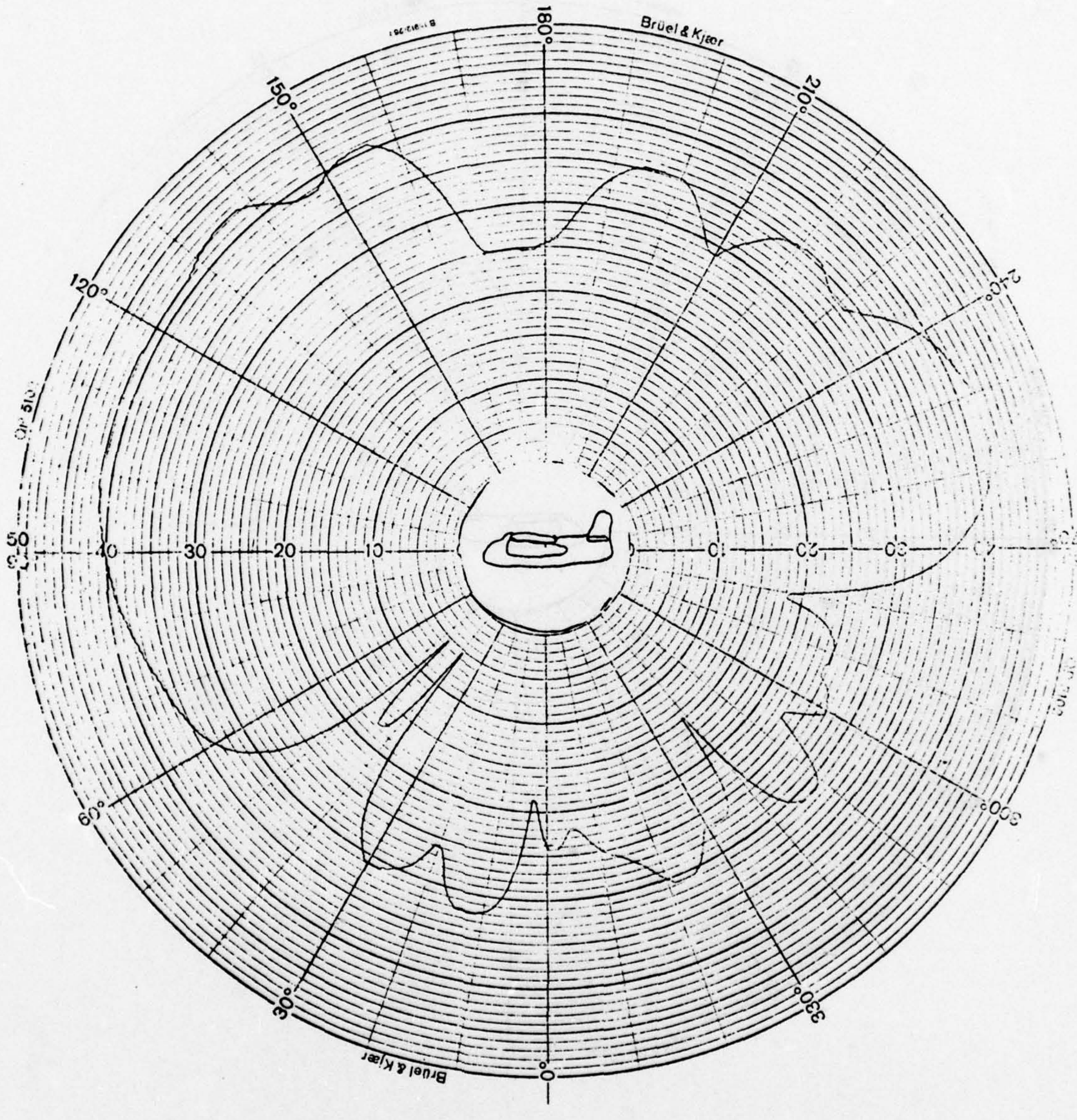
PATTERN PLANE *YAW* ✓ *PITCH* ____ *ROLL* ____

ANTENNA TYPE VHF - AM

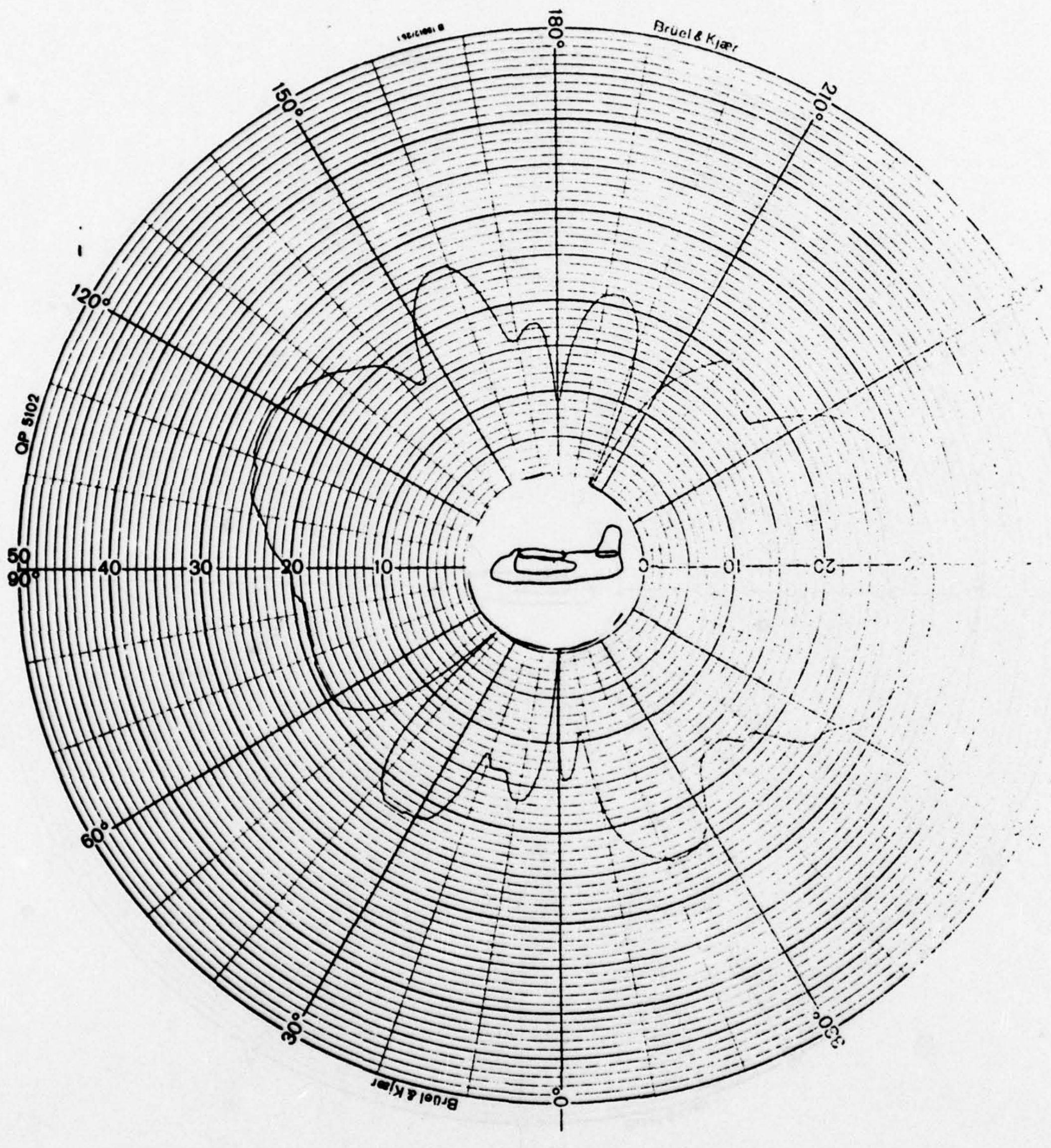
ANTENNA LOCATION TOP OF WING



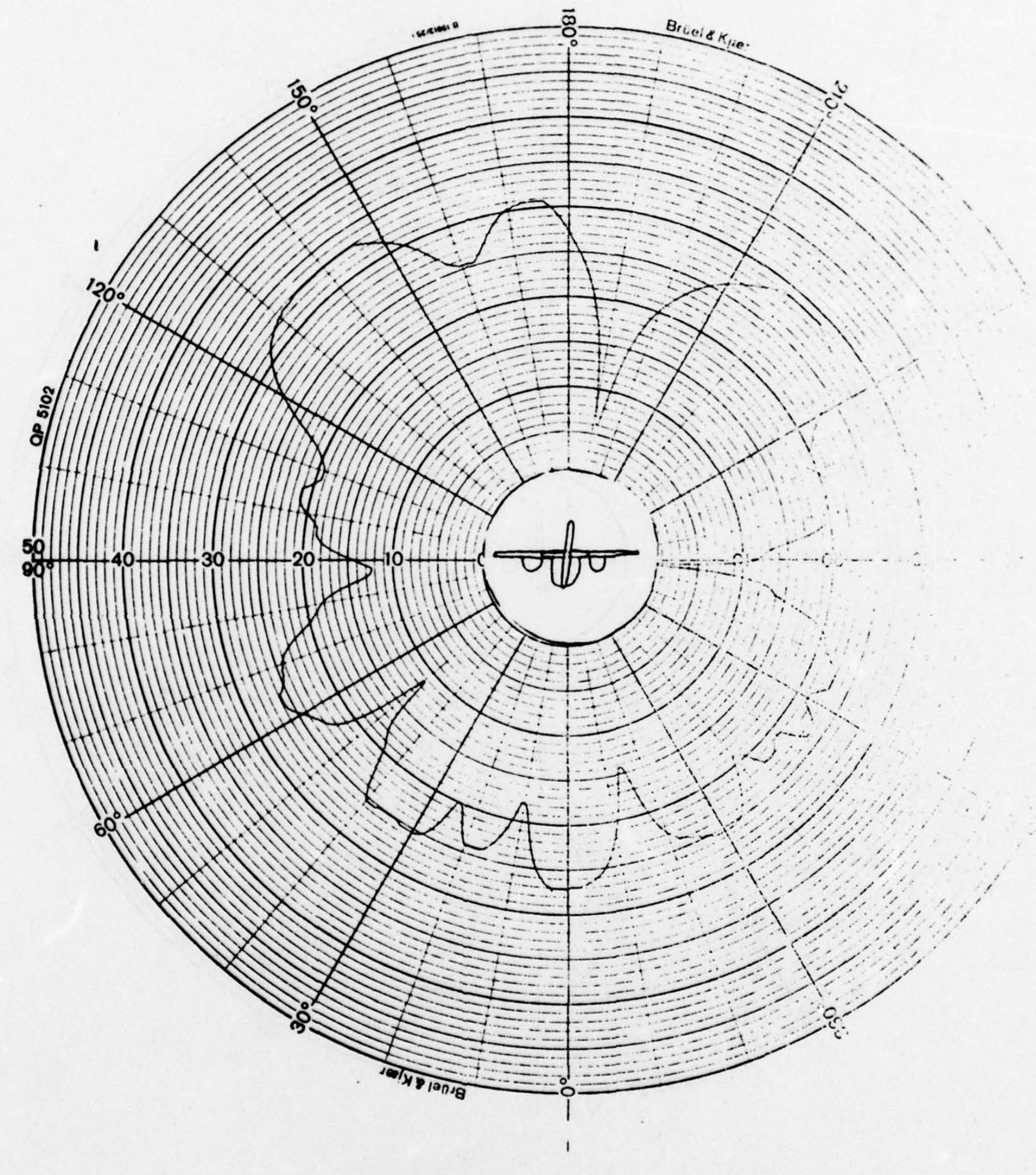
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 14 *POLARIZATION* E_θ ____ E_ϕ ✓
PATTERN PLANE *YAW* ✓ *PITCH* ____ *ROLL* ____
ANTENNA TYPE VHF - AM
ANTENNA LOCATION TOP OF WING



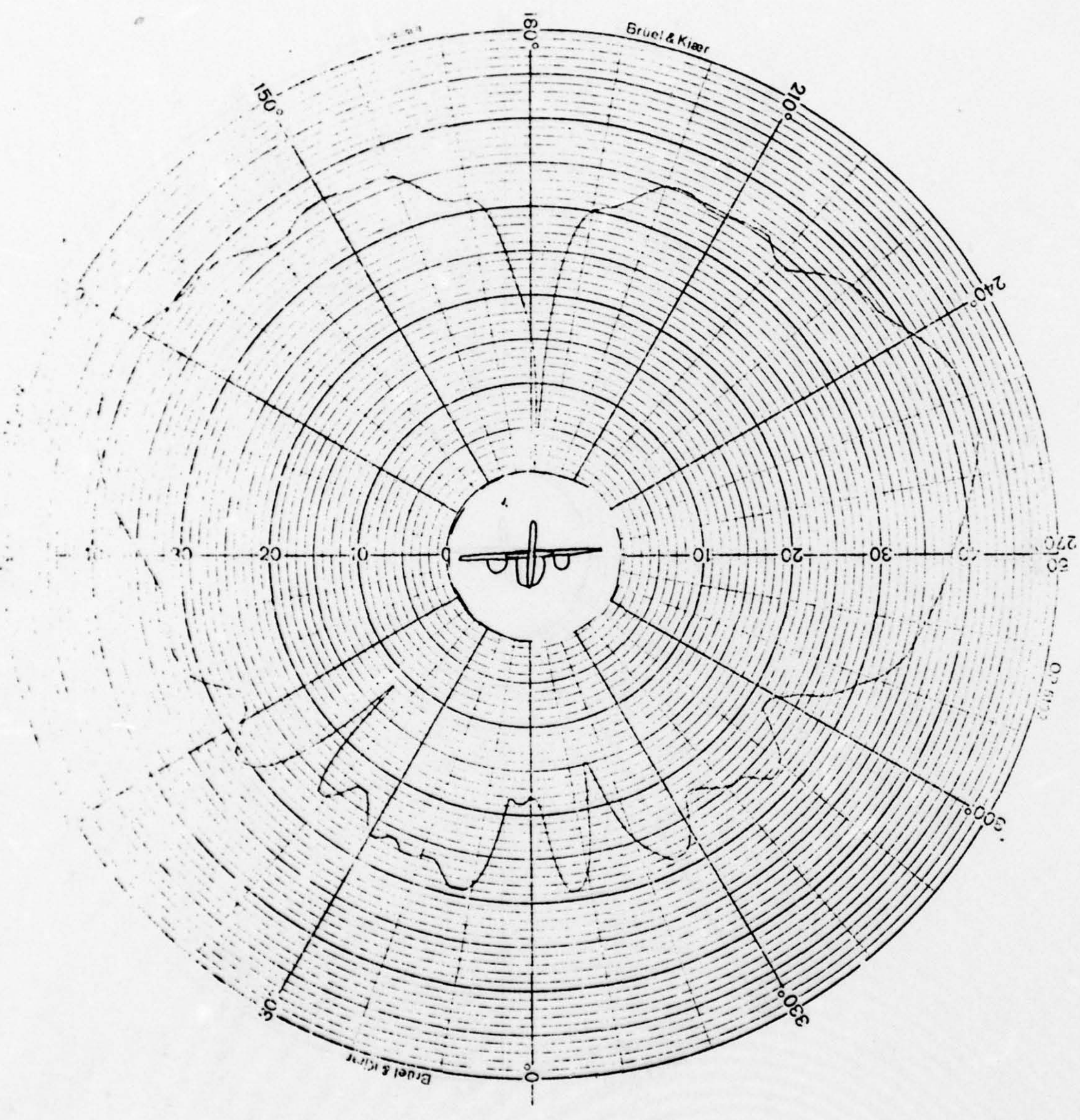
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 15 *POLARIZATION* E_θ ✓ E_ϕ ___
PATTERN PLANE YAW ___ *PITCH* ✓ *ROLL* ___
ANTENNA TYPE VHF-AM
ANTENNA LOCATION TOP OF WING



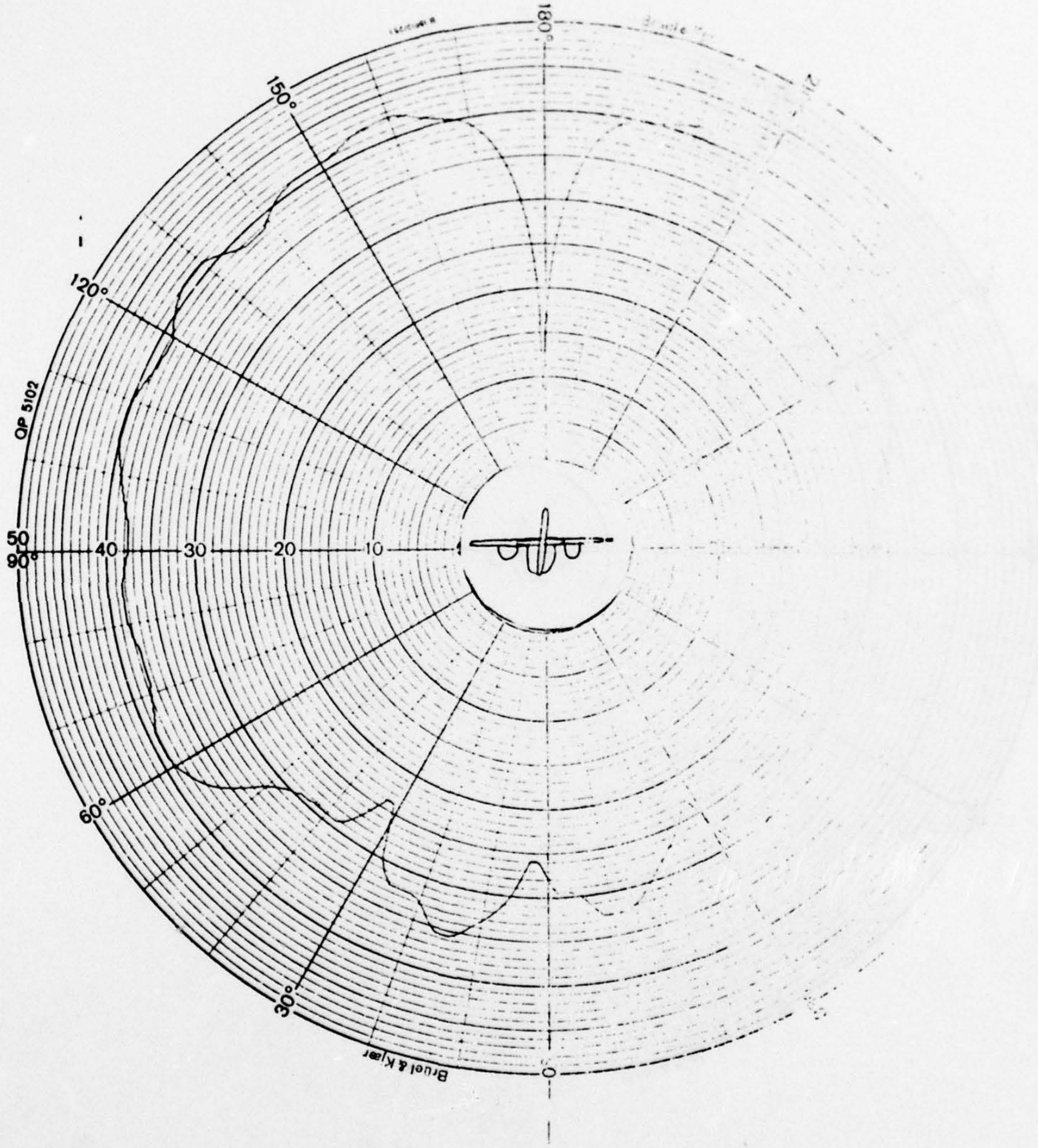
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 16 *POLARIZATION* E_θ ____ E_ϕ ✓
PATTERN PLANE YAW ____ *PITCH* ✓ *ROLL* ____
ANTENNA TYPE VHF-AM
ANTENNA LOCATION TOP OF WING



TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 17 *POLARIZATION* E_θ ____ E_ϕ ✓
PATTERN PLAN YAW ____ *PITCH* ____ *ROLL* ✓
ANTENNA TYPE VHF-AM
ANTENNA LOCATION TOP OF WING



TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 18 *POLARIZATION* E_θ ✓ E_ϕ ____
PATTERN PLANE *YAW* ____ *PITCH* ____ *ROLL* ✓
ANTENNA TYPE VHF-AM
ANTENNA LOCATION TOP OF WING



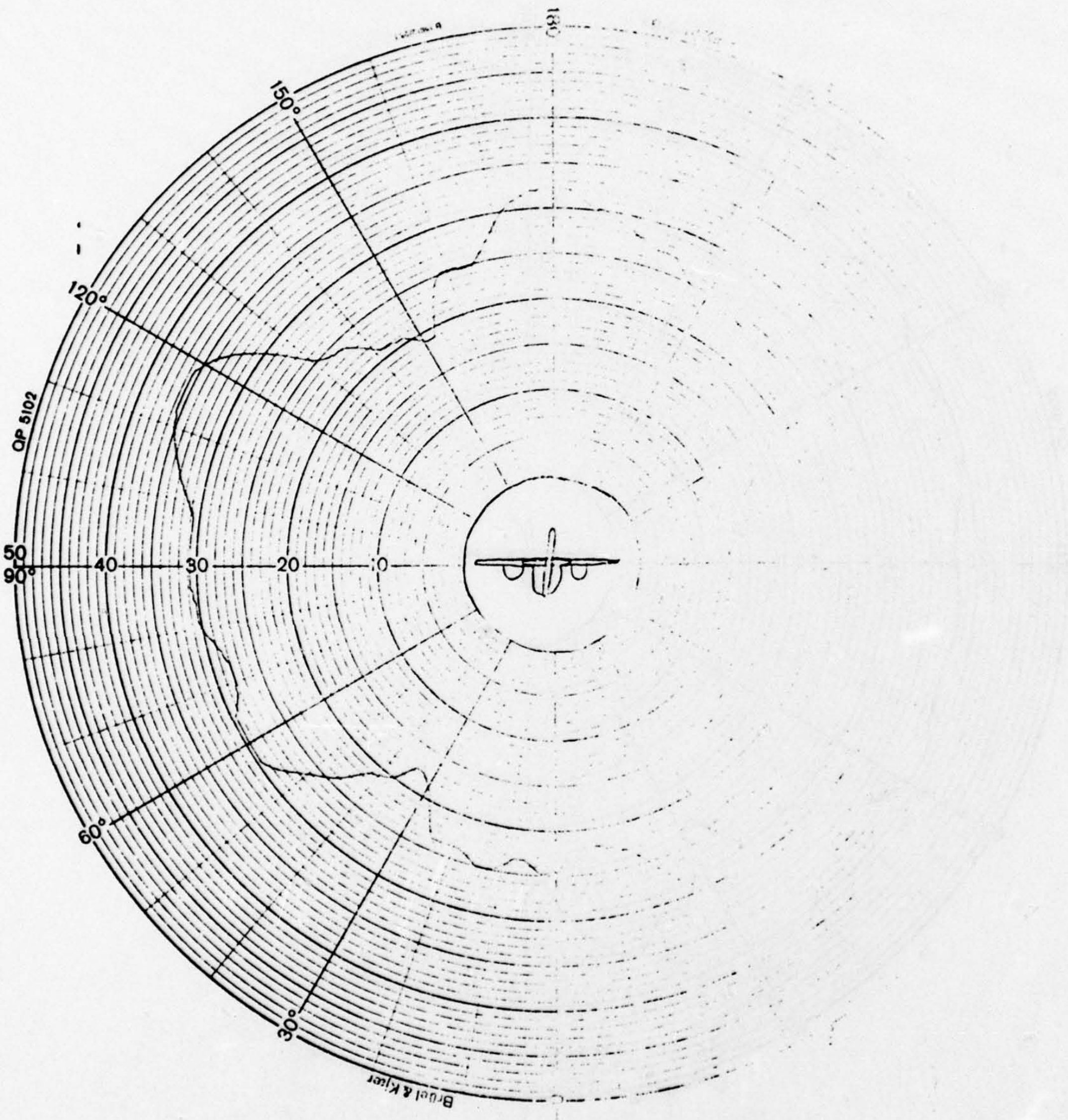
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)

PLOT NO. 19 *POLARIZATION* E_θ ✓ E_ϕ ____

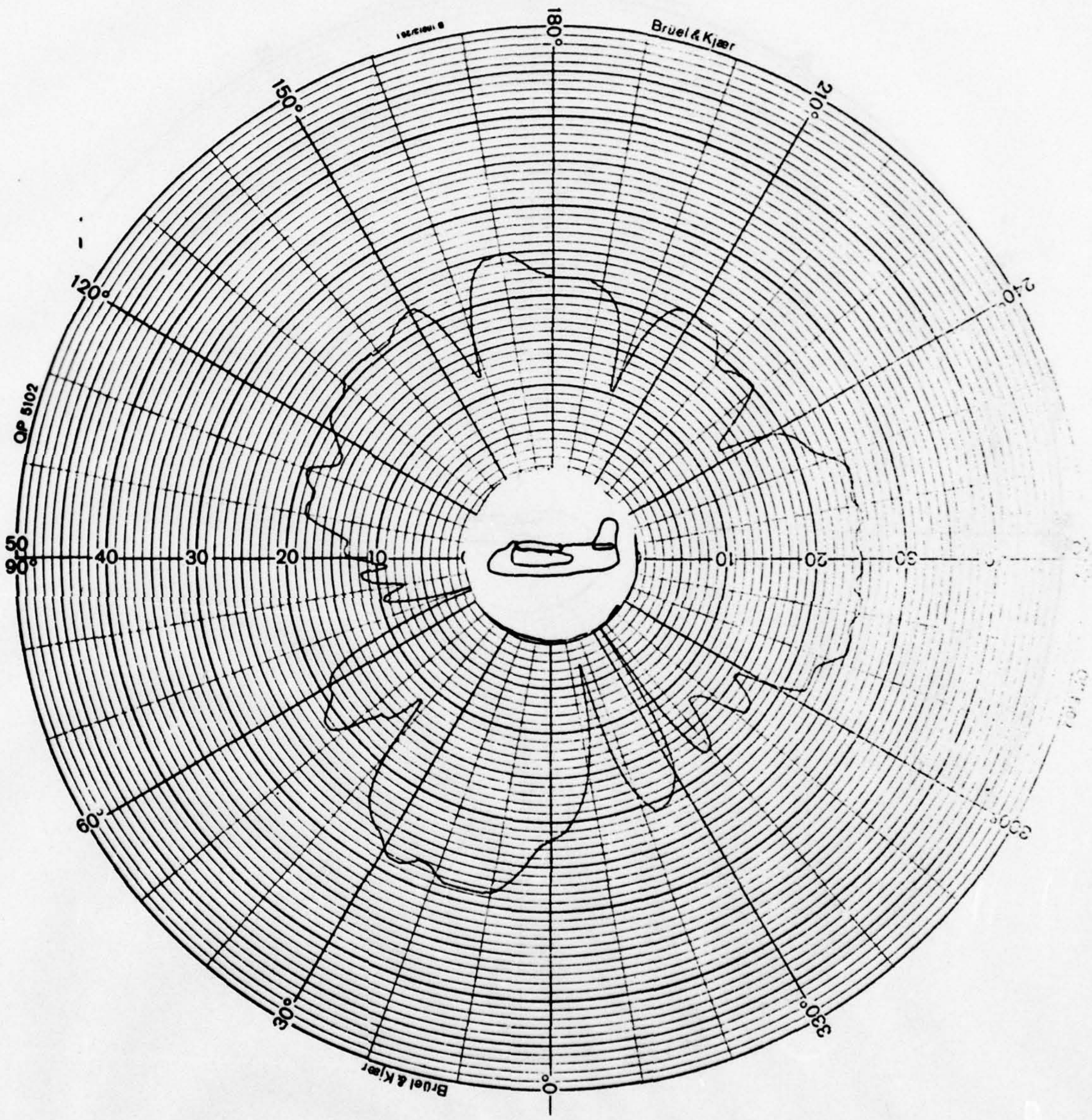
PATTERN PLANE *YAW* ____ *PITCH* ____ *ROLL* ✓

ANTENNA TYPE VHF-AM

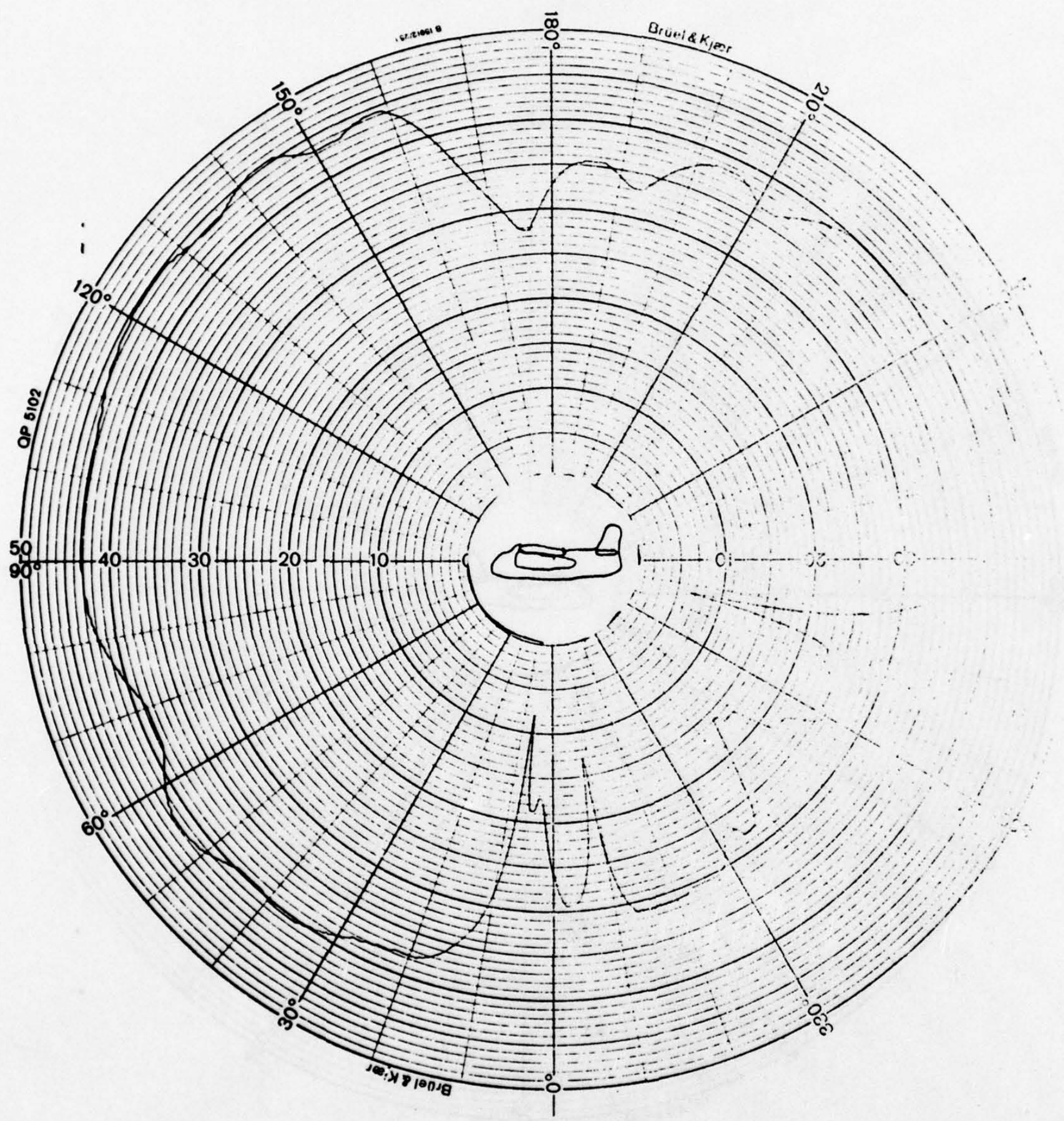
ANTENNA LOCATION TOP OF CABIN



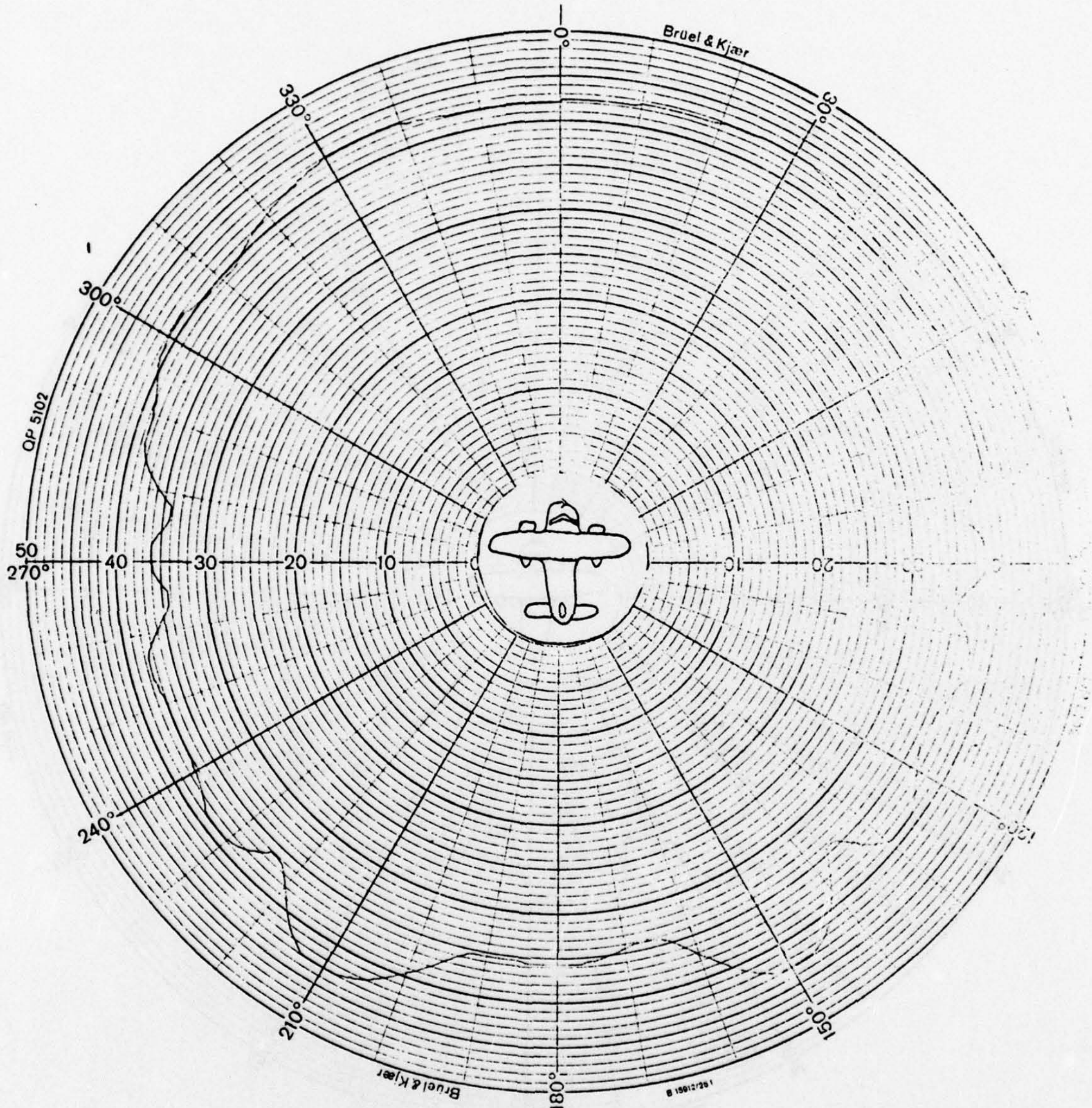
TRACKER AIRCRAFT ANTENNA PATTERNS (POLOR PLOTS)
PLOT NO. 20 *POLARIZATION* E_θ ____ E_ϕ ✓
PATTERN PLANE YAW ____ *PITCH* ____ *ROLL* ✓
ANTENNA TYPE VHF-AM
ANTENNA LOCATION TOP OF CABIN



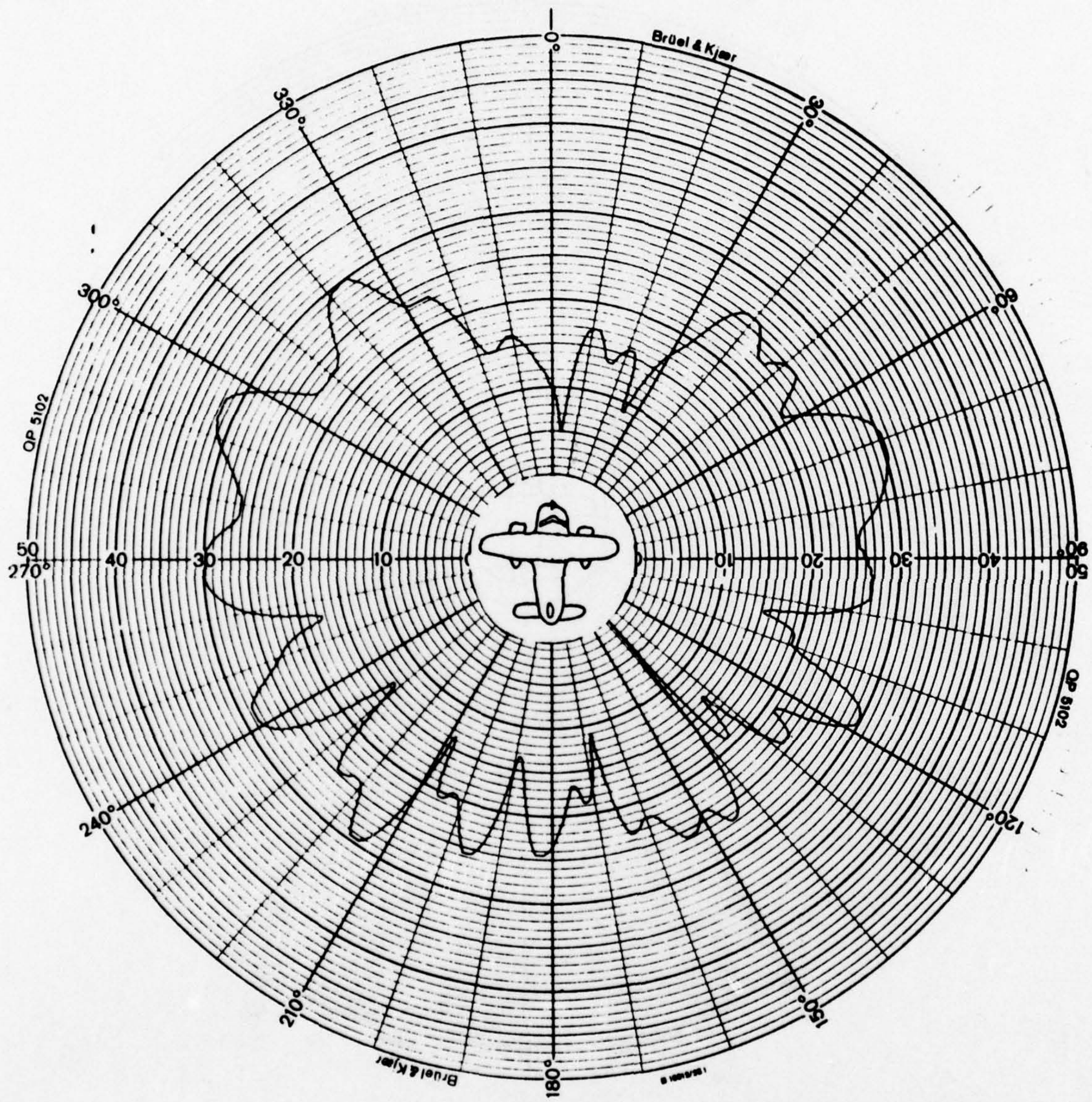
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 21 *POLARIZATION* E_θ ___ E_ϕ ✓
PATTERN PLANE YAW ___ *PITCH* ✓ *ROLL* ___
ANTENNA TYPE VHF-AM
ANTENNA LOCATION TOP OF CABIN



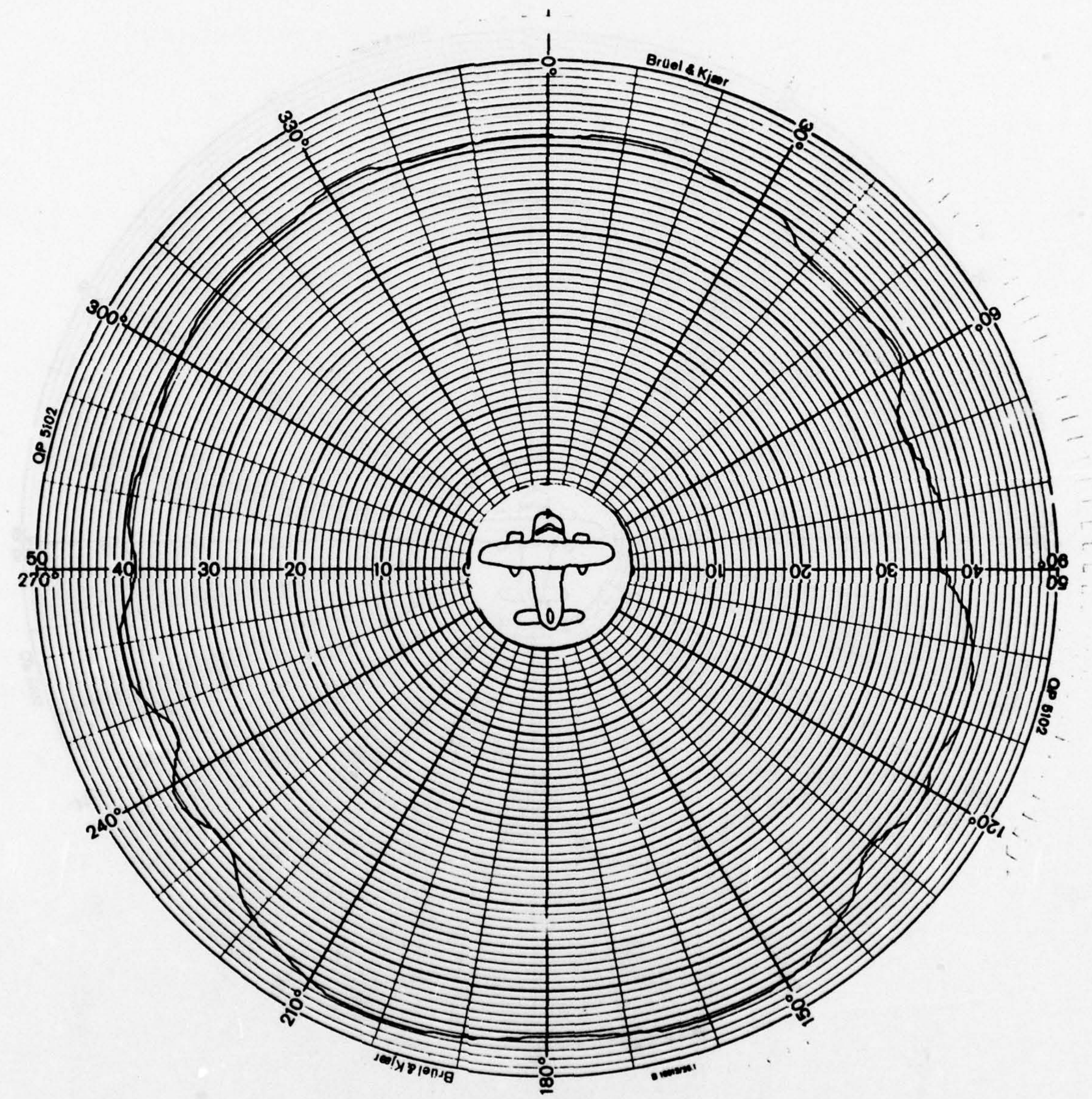
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 22 *POLARIZATION* E_θ ✓ E_ϕ ____
PATTERN PLANE *YAW* ____ *PITCH* ✓ *ROLL* ____
ANTENNA TYPE VHF-AM
ANTENNA LOCATION TOP OF CABIN



TRACKER AIRCRAFT ANTENNA PATTTERNS (POLAR PLOTS)
PLOT NO. 23 *POLARIZATION* E_θ ✓ E_ϕ ____
PATTERN PLANE *YAW* ✓ *PITCH* ____ *ROLL* ___
ANTENNA TYPE VHF-AM
ANTENNA LOCATION TOP OF CABIN



TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 24 *POLARIZATION* E_{Θ} ____ E_{ϕ} ✓
PATTERN PLANE *YAW* ✓ *PITCH* ____ *ROLL* ____
ANTENNA TYPE VHF-AM
ANTENNA LOCATION TOP OF CABIN



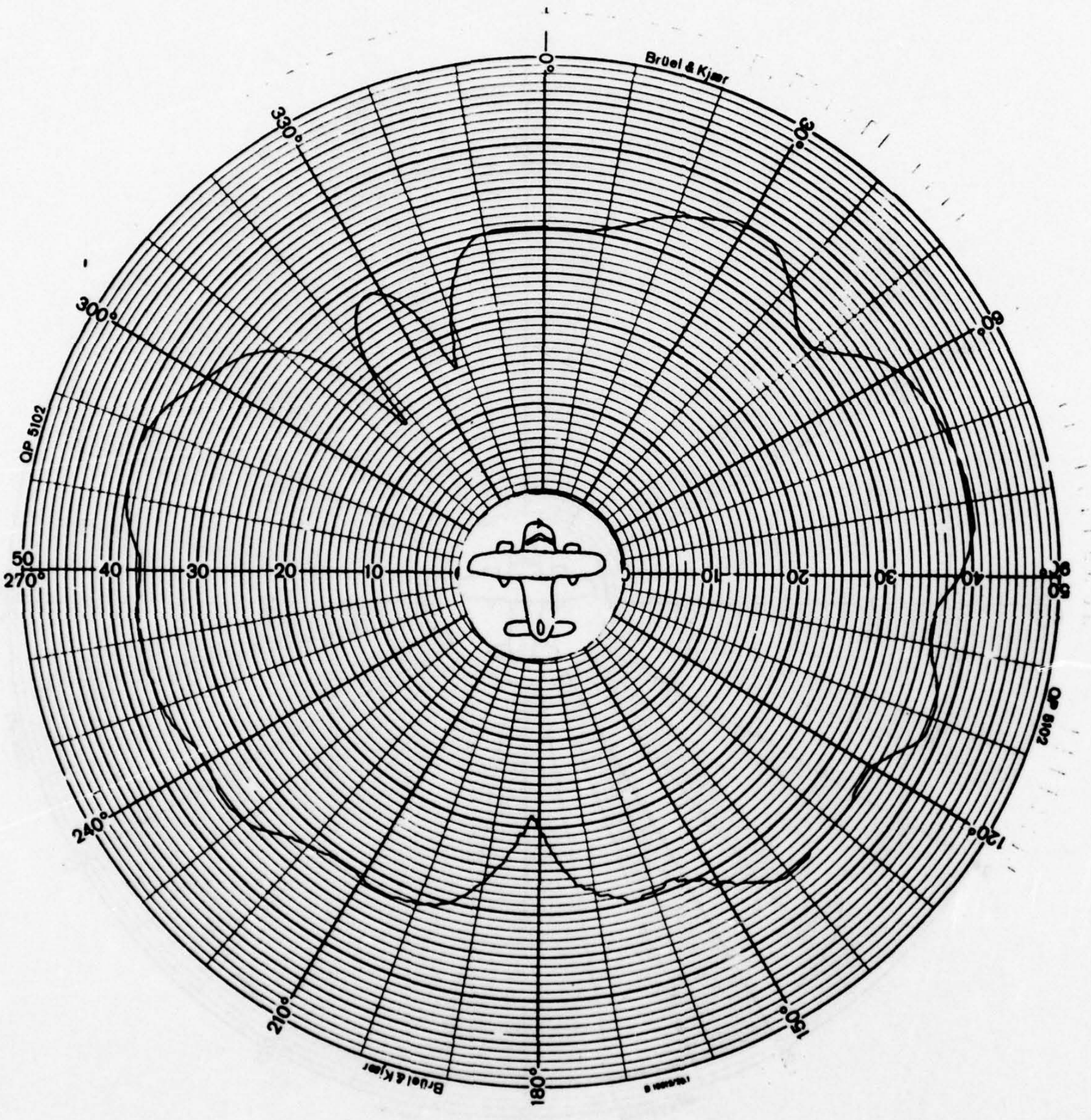
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)

PLOT NO. 25 *POLARIZATION* E_θ ____ E_ϕ ✓

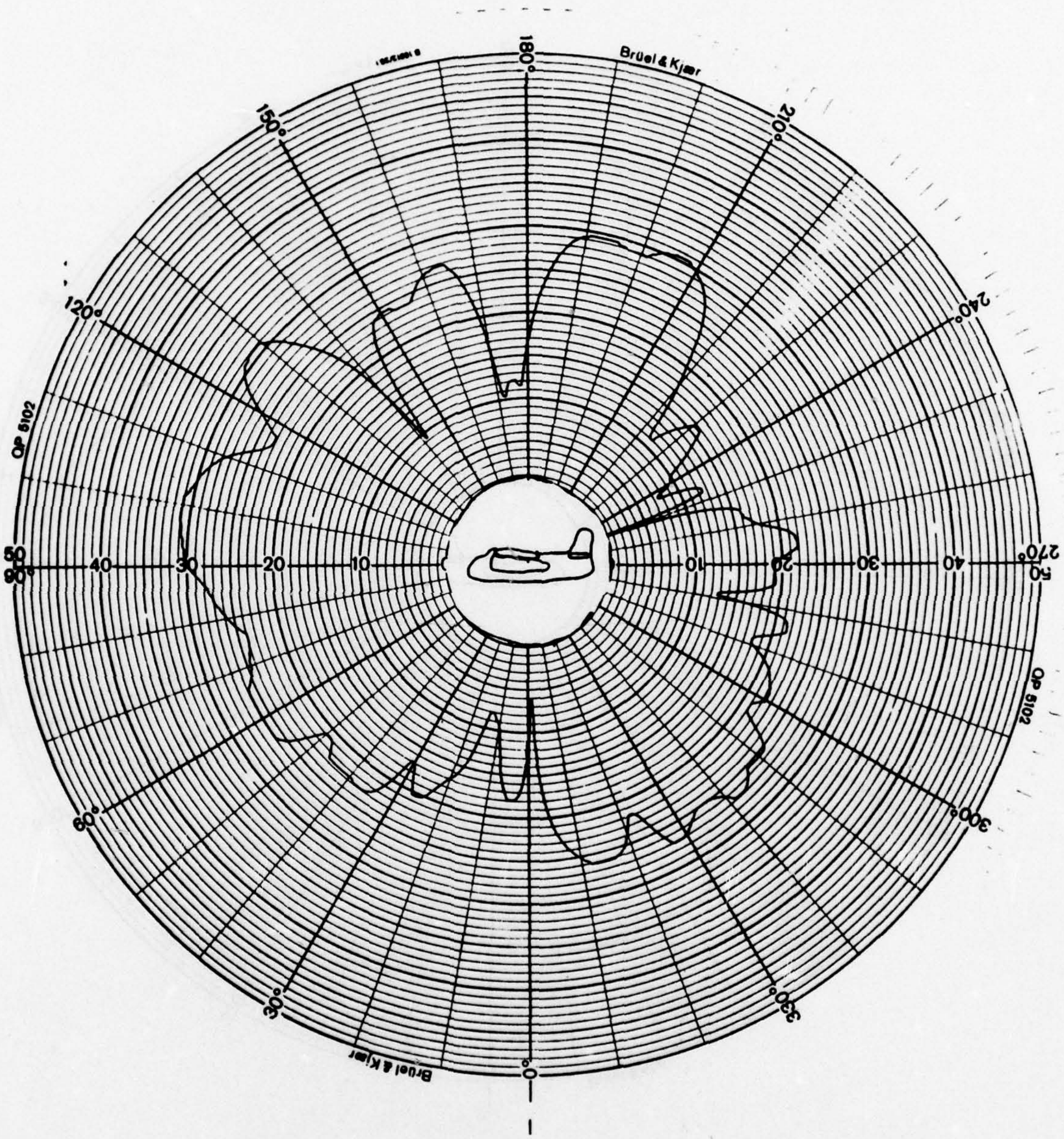
PATTERN PLANE *YAW* ✓ *PITCH* ____ *ROLL* ____

ANTENNA TYPE VOR-LOC

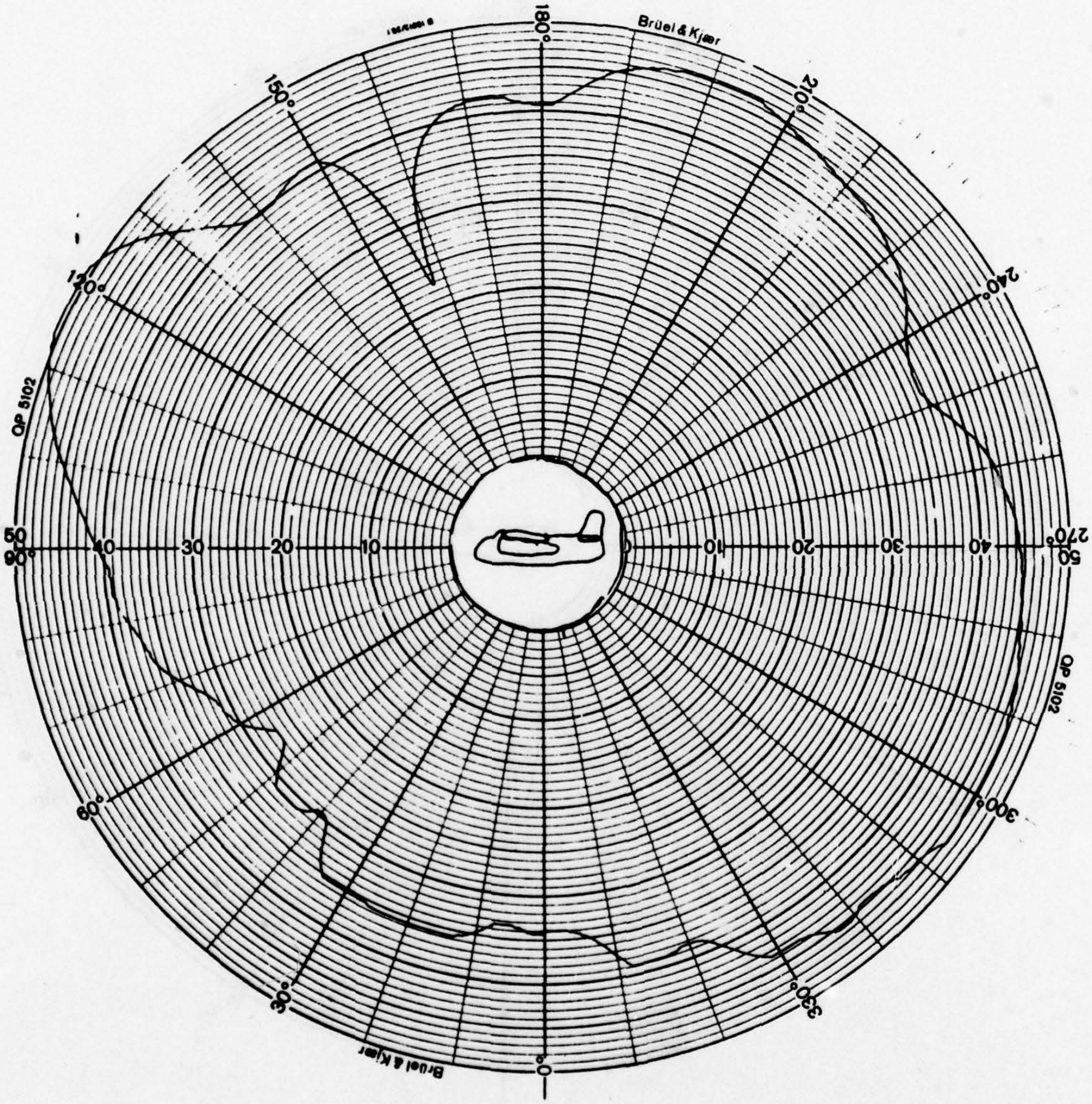
ANTENNA LOCATION WHIPS, TAILS FORWARD, BASE AT HINGE



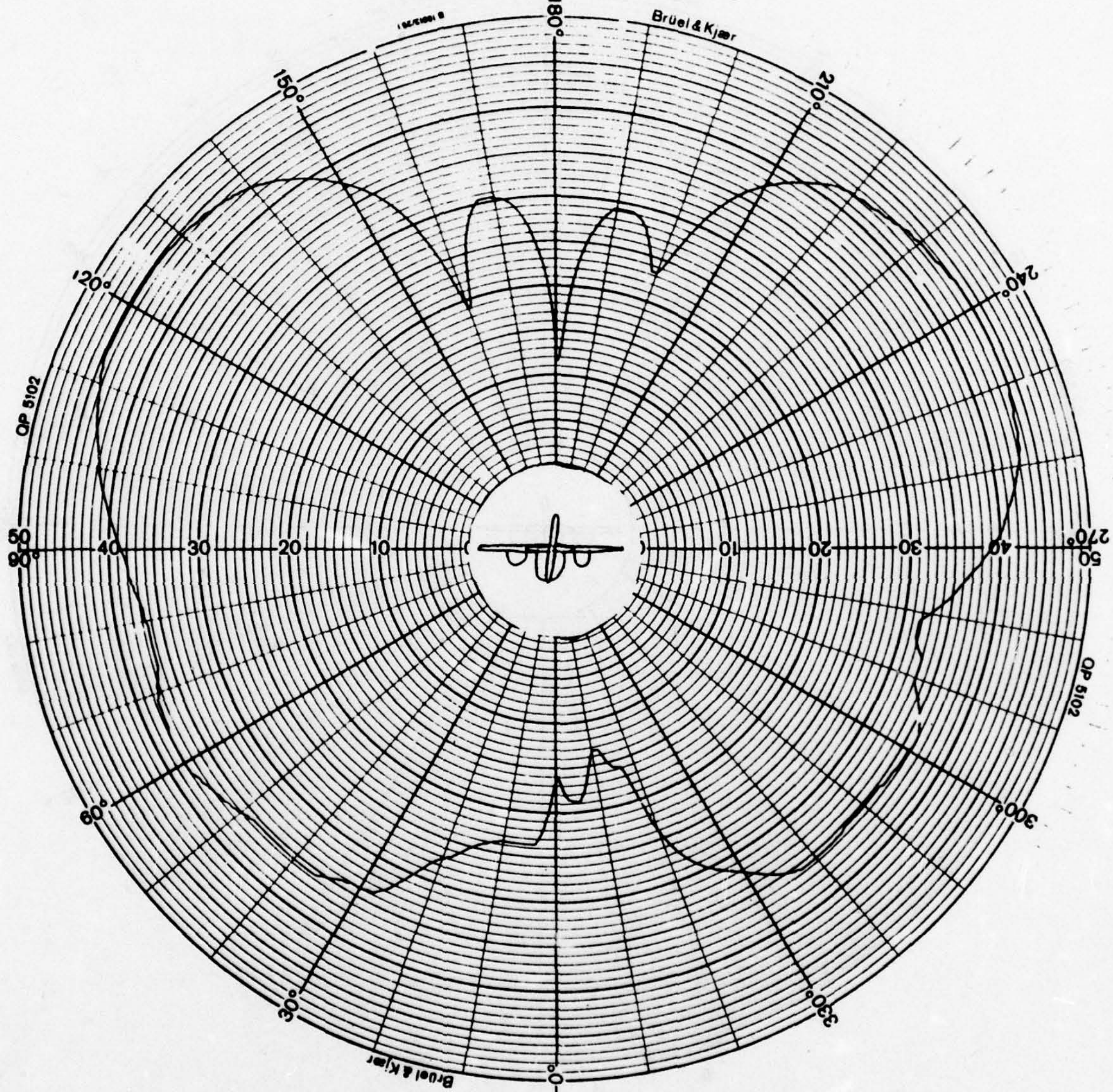
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 26 *POLARIZATION* E_{θ} ____ E_{ϕ} ✓
PATTERN PLANE YAW ____ *PITCH* ____ *ROLL* ✓
ANTENNA TYPE VOR-LOC
ANTENNA LOCATION WHIPS, TAILS FORWARD, BASE AT HINGE



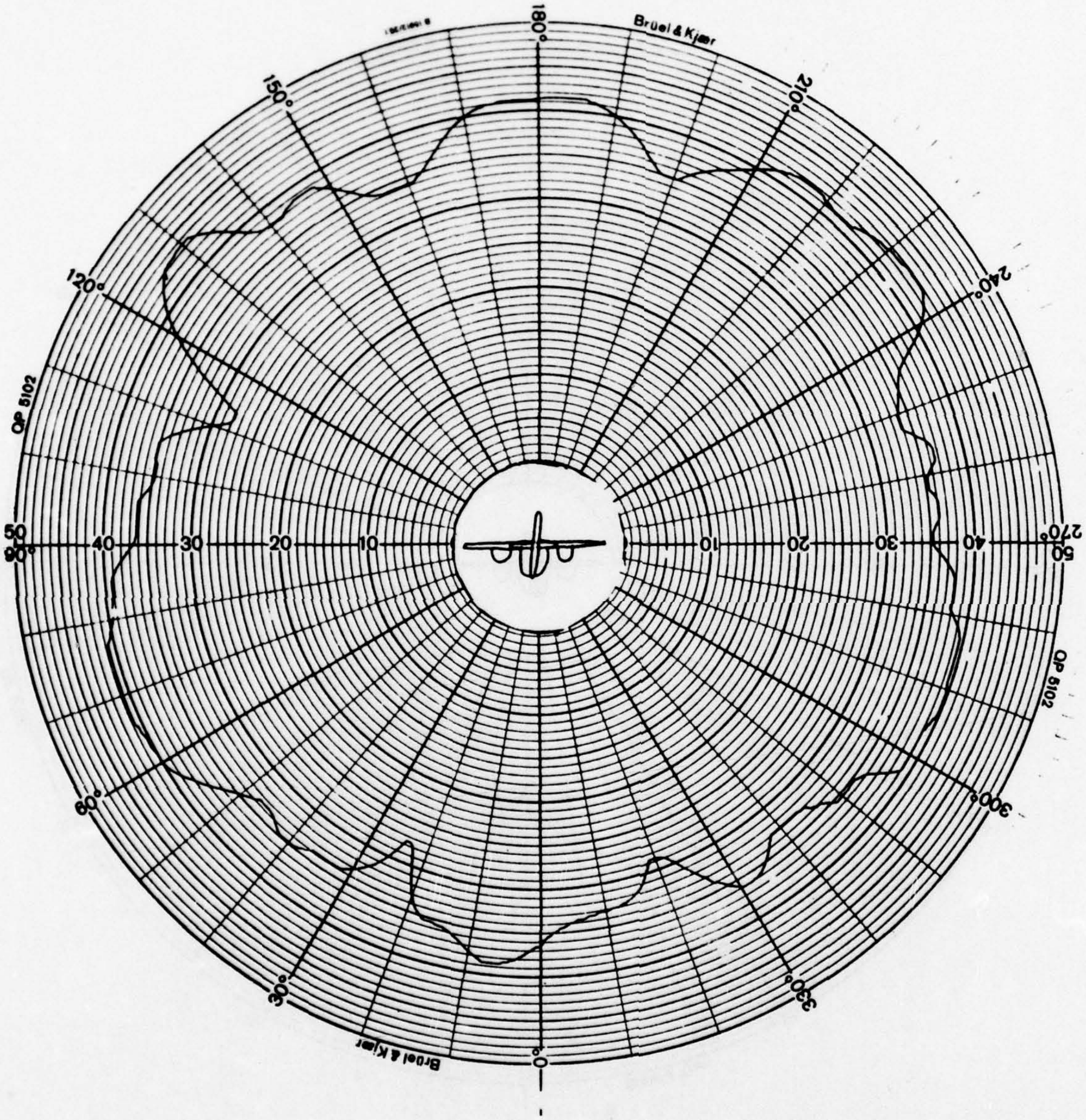
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 27 *POLARIZATION* E_θ ✓ E_ϕ ___
PATTERN PLANE YAW ___ *PITCH* ✓ *ROLL* ___
ANTENNA TYPE VOR-LOC
ANTENNA LOCATION WHIPS, TAILS FORWARD, BASE AT HINGE



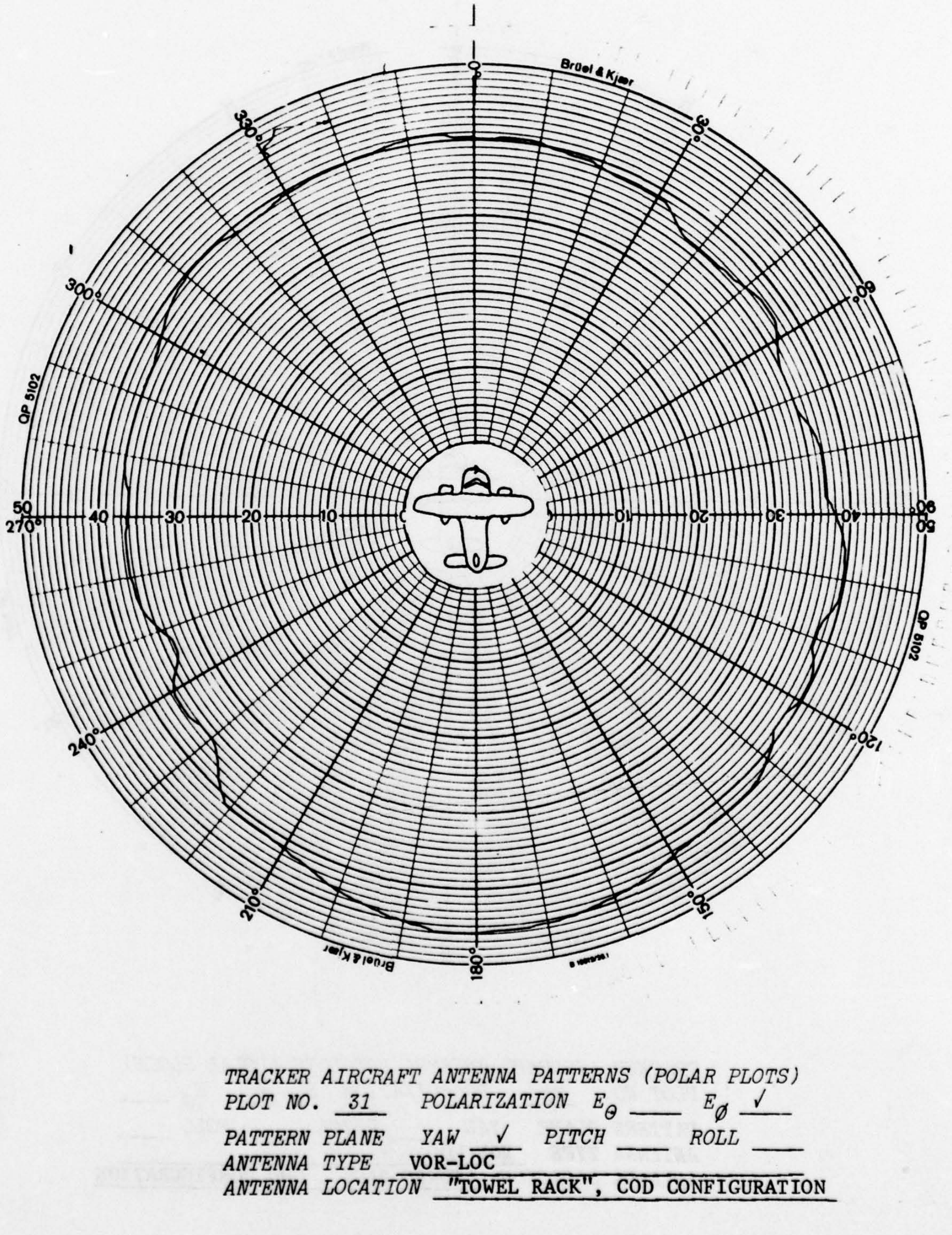
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 28 *POLARIZATION* E_θ ____ E_ϕ ✓
PATTERN PLANE YAW ____ *PITCH* ✓ *ROLL* ____
ANTENNA TYPE VOR-LOC
ANTENNA LOCATION WHIPS, TAILS FORWARD, BASE AT HINGE



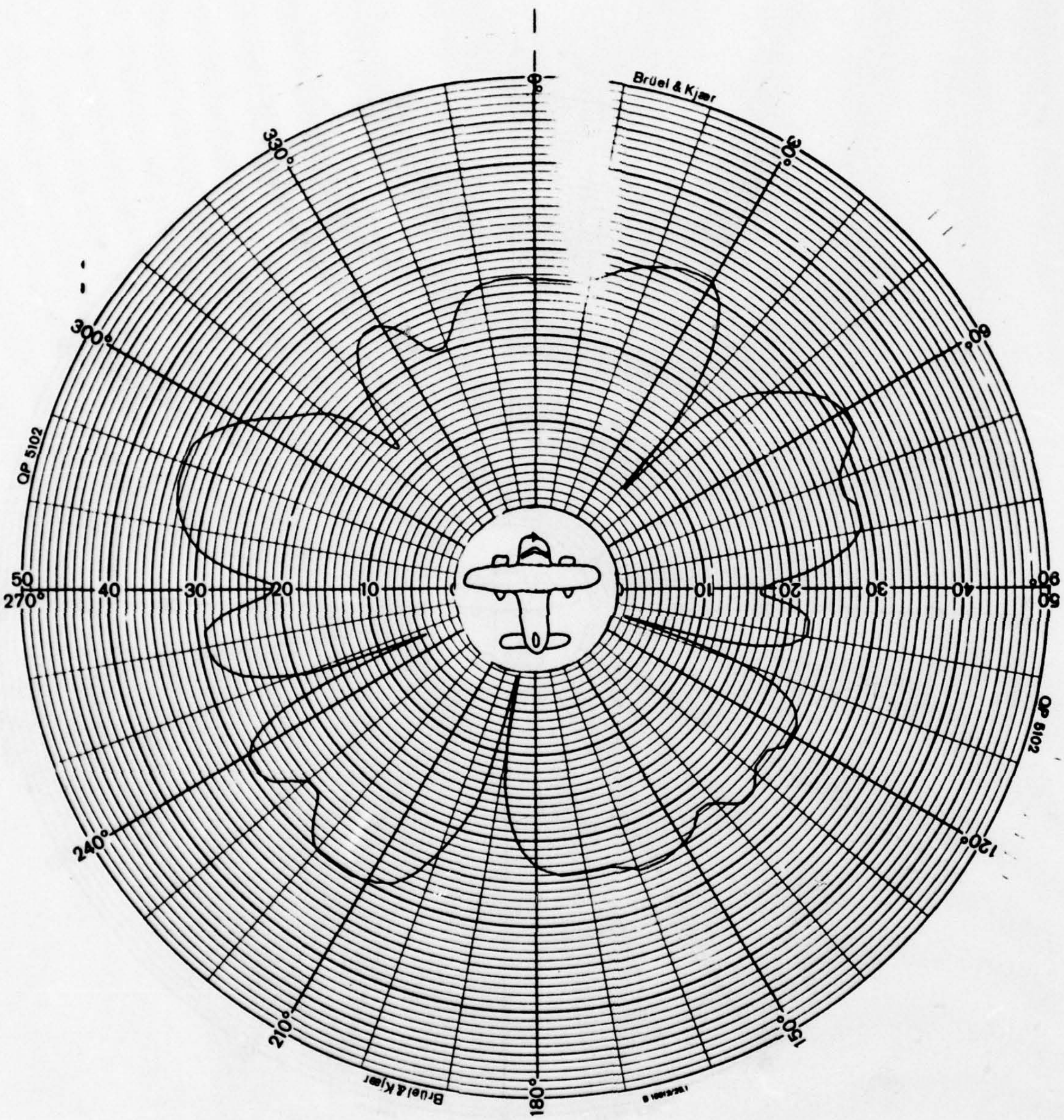
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 29 *POLARIZATION* E_θ ____ E_ϕ ✓
PATTERN PLANE YAW ____ *PITCH* ____ *ROLL* ✓
ANTENNA TYPE VOR-LOC
ANTENNA LOCATION WHIPS, TAILS FORWARD, BASE AT HINGE



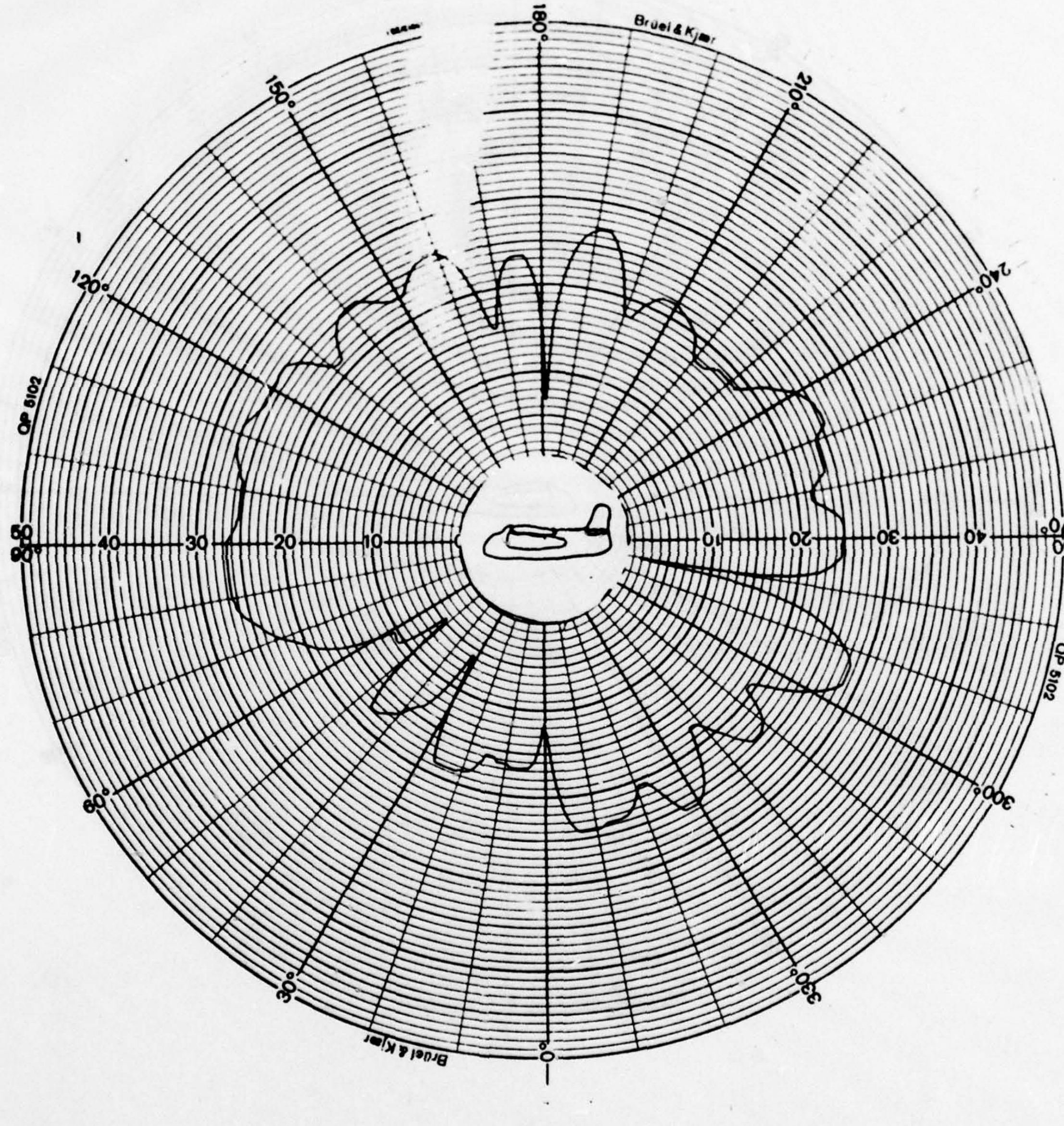
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 30 *POLARIZATION* E_θ ✓ E_ϕ ____
PATTERN PLANE *YAW* ____ *PITCH* ____ *ROLL* ✓
ANTENNA TYPE VOR-LOC
ANTENNA LOCATION WHIPS, TAILS FORWARD, BASE AT HINGE



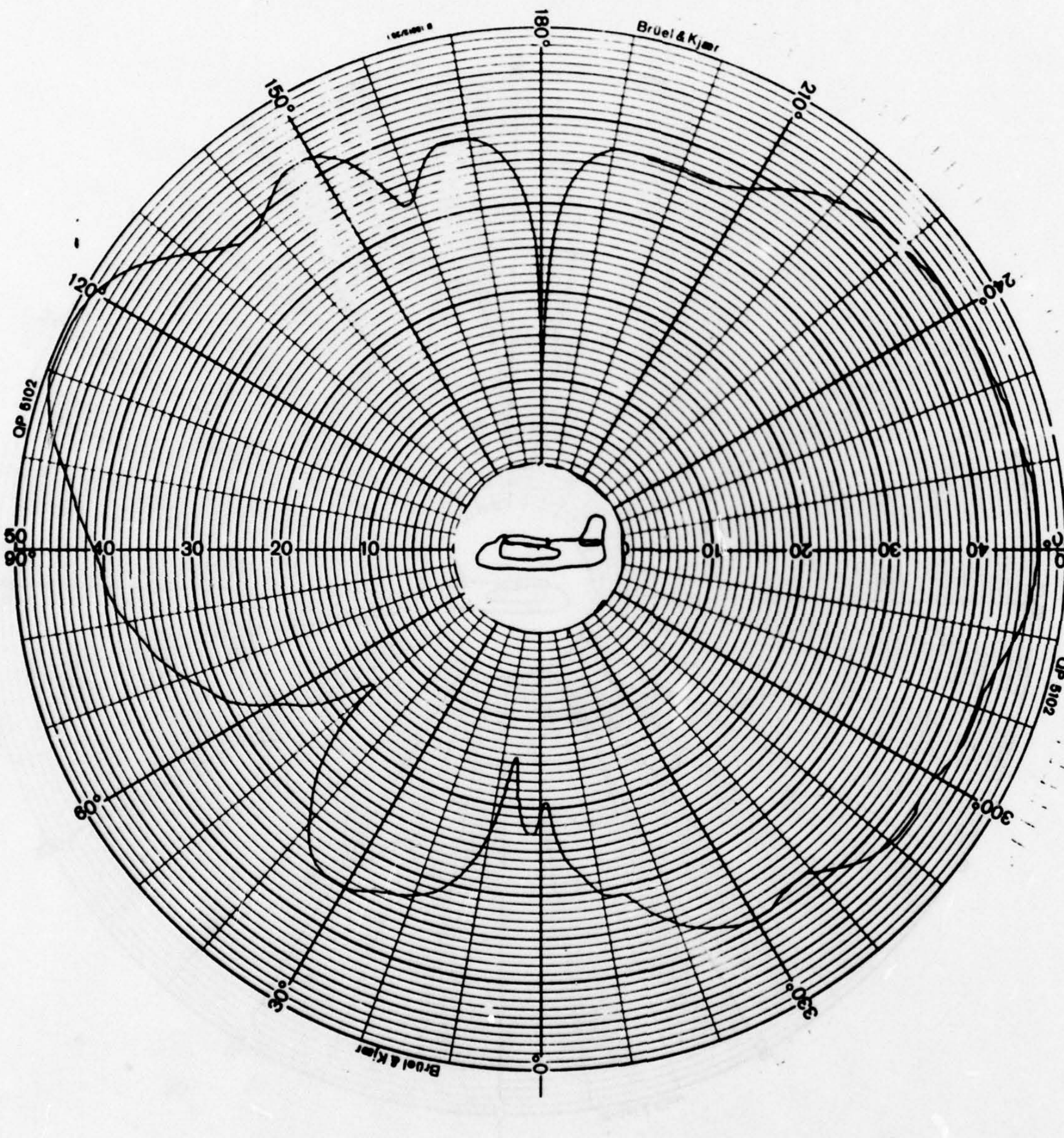
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 31 *POLARIZATION* E_θ ____ E_ϕ ✓
PATTERN PLANE *YAW* ✓ *PITCH* ____ *ROLL* ____
ANTENNA TYPE VOR-LOC
ANTENNA LOCATION "TOWEL RACK", COD CONFIGURATION



TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 32 *POLARIZATION* E_θ ✓ E_ϕ ____
PATTERN PLANE YAW ✓ *PITCH* ____ *ROLL* ____
ANTENNA TYPE VOR-LOC
ANTENNA LOCATION "TOWEL RACK", COD CONFIGURATION



TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 33 *POLARIZATION* E_θ ✓ E_ϕ ___
PATTERN PLANE *YAW* ___ *PITCH* ✓ *ROLL* ___
ANTENNA TYPE VOR-LOC
ANTENNA LOCATION "TOWEL RACK", COD CONFIGURATION



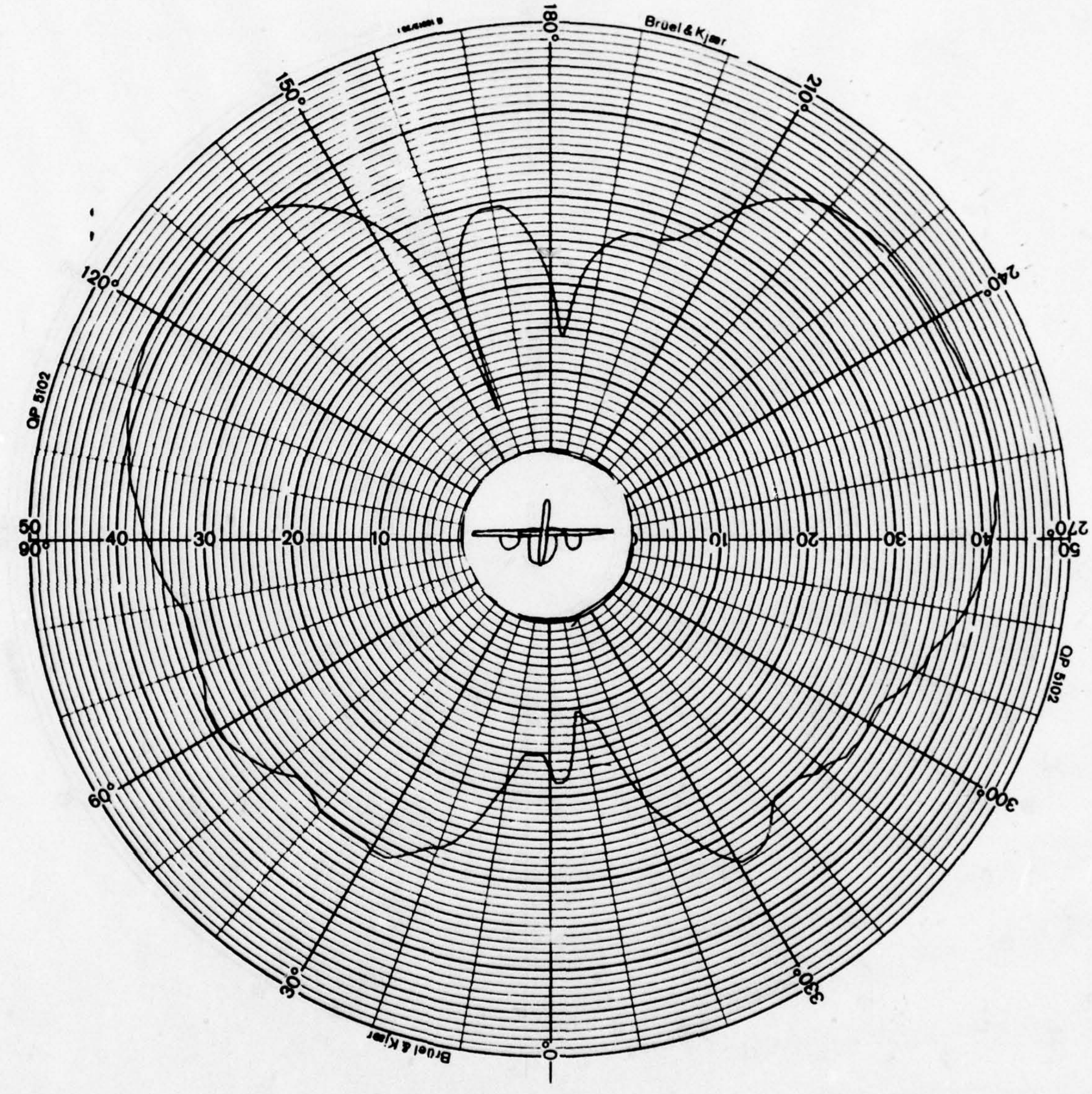
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)

PLOT NO. 34 *POLARIZATION* E_{Θ} ____ E_{ϕ} ✓

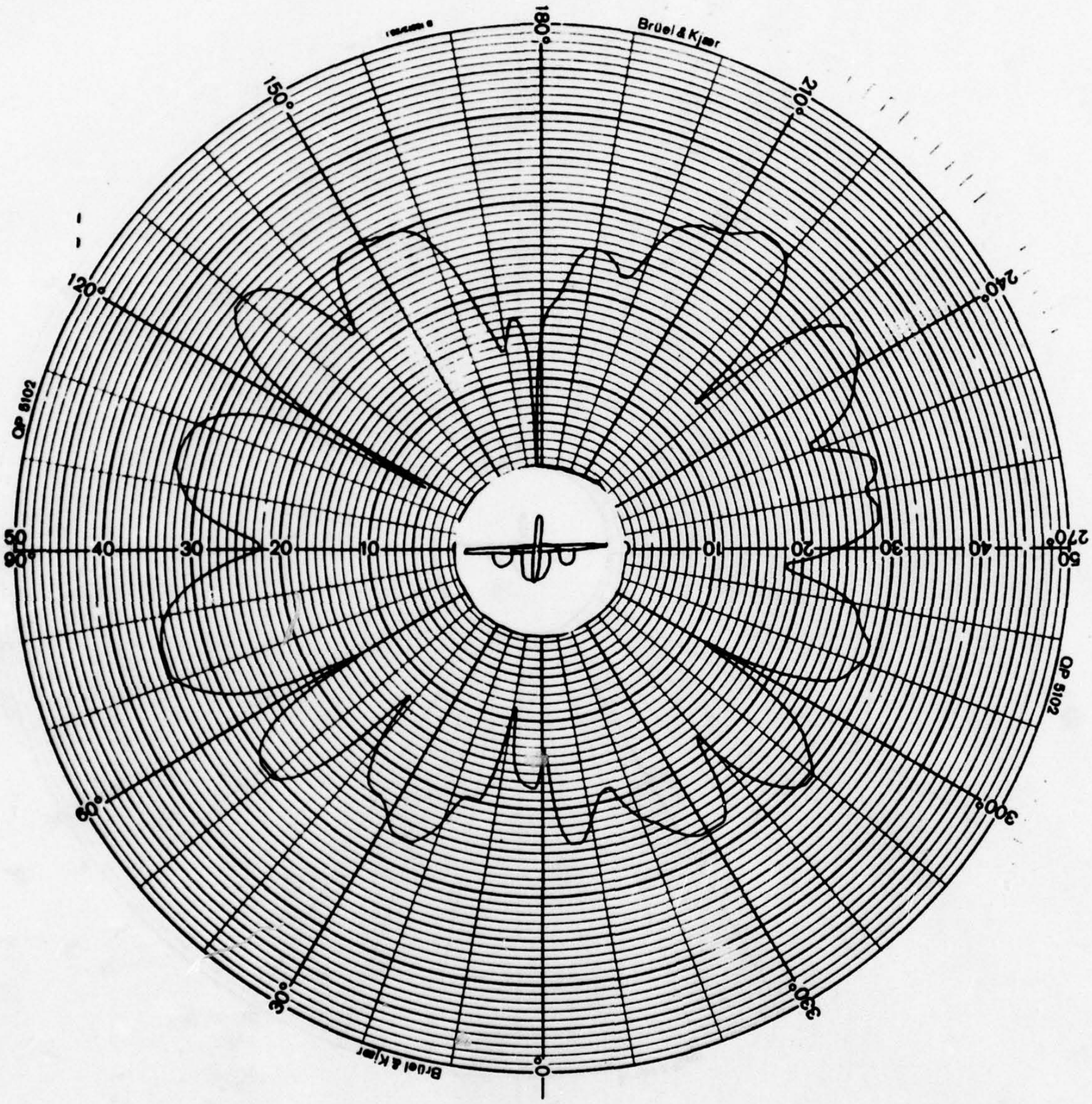
PATTERN PLANE YAW ____ *PITCH* ✓ *ROLL* ____

ANTENNA TYPE VOR-LOC

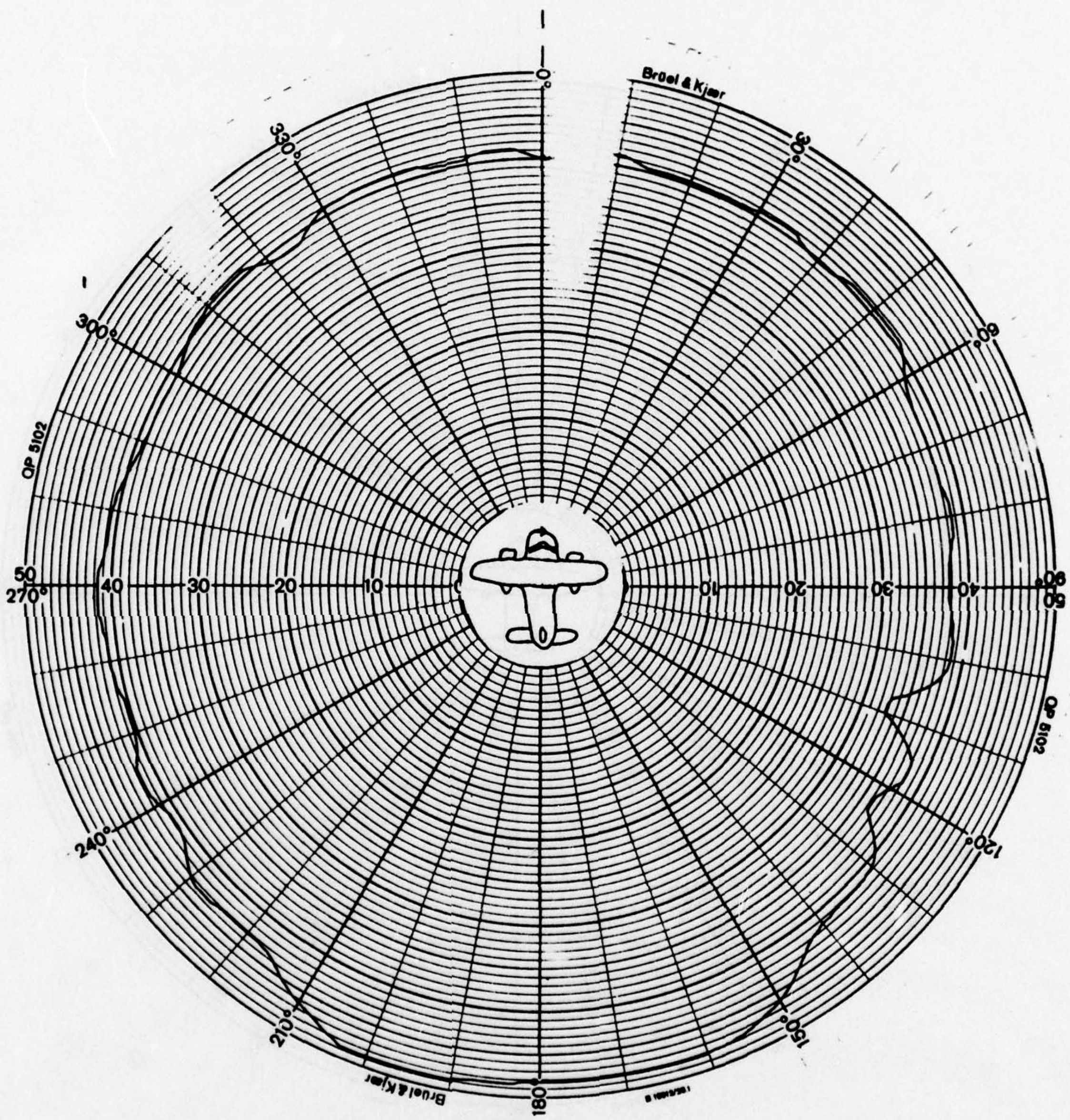
ANTENNA LOCATION "TOWEL RACK", COD CONFIGURATION



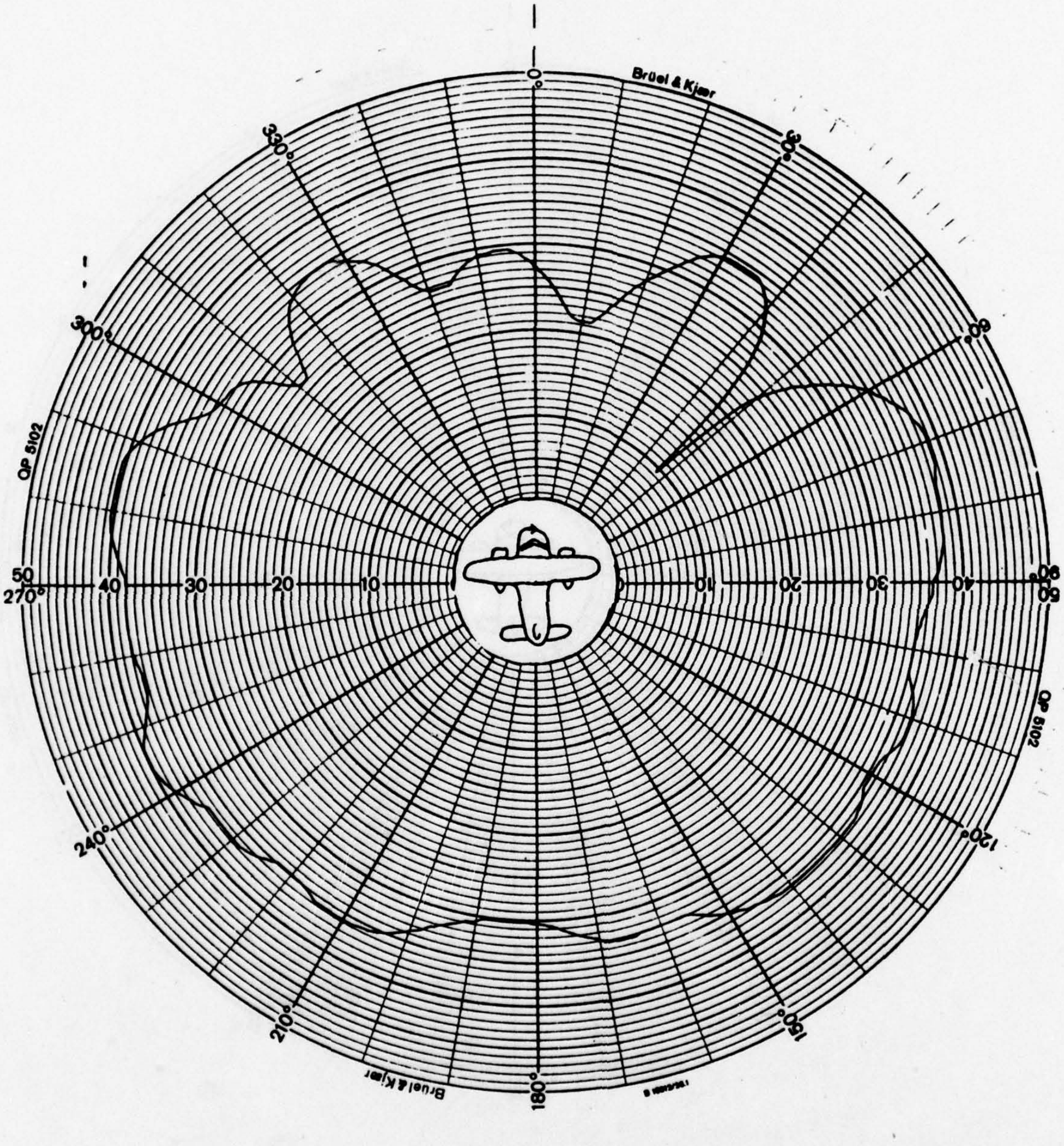
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 35 *POLARIZATION* E_θ ____ E_ϕ ✓
PATTERN PLANE YAW ____ *PITCH* ____ *ROLL* ✓
ANTENNA TYPE VOR-LOC
ANTENNA LOCATION "TOWEL RACK", COD CONFIGURATION



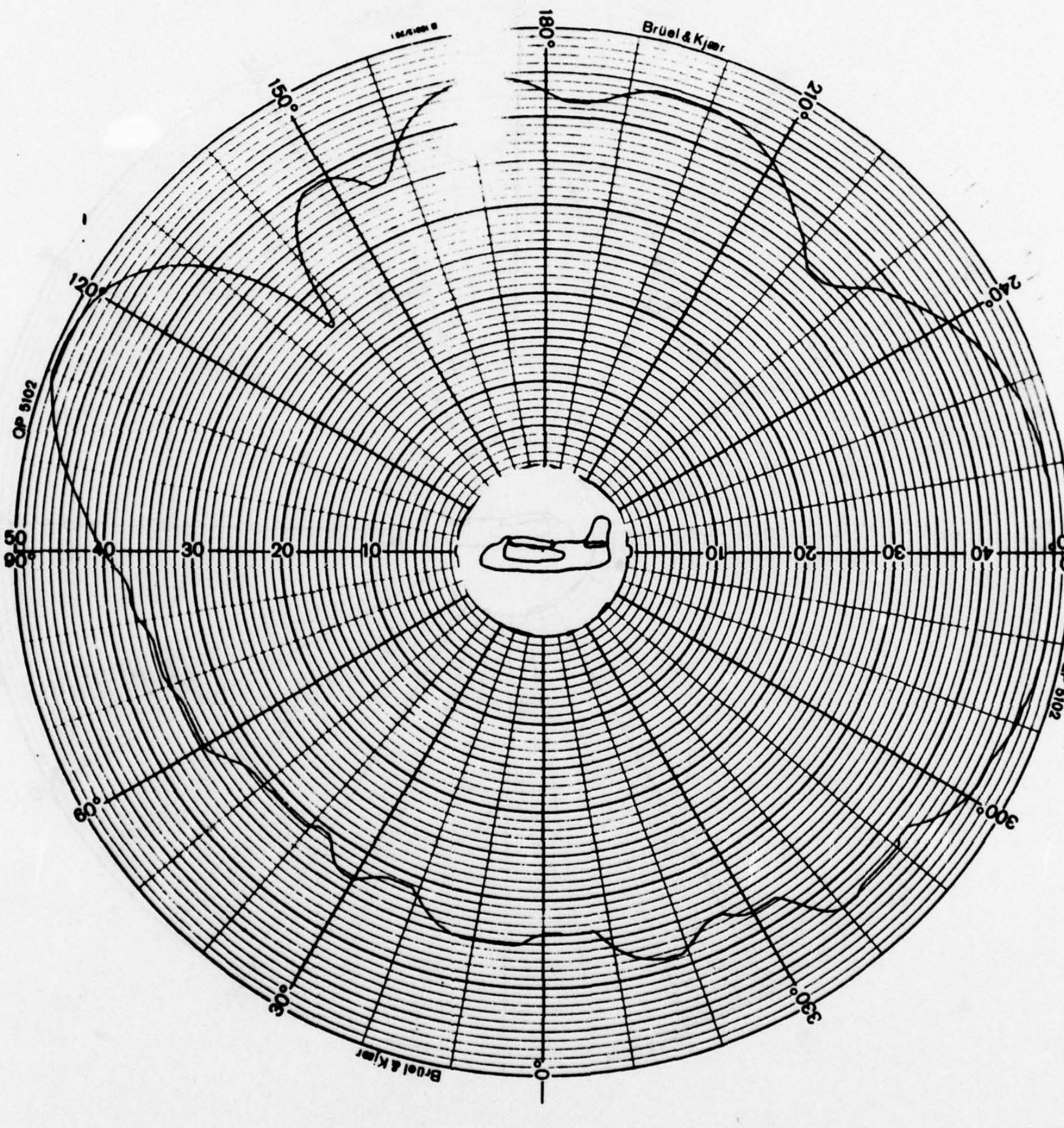
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 36 *POLARIZATION* E_θ ✓ E_ϕ ____
PATTERN PLANE YAW ____ *PITCH* ____ *ROLL* ✓
ANTENNA TYPE VOR-LOC
ANTENNA LOCATION "TOWEL RACK", COD CONFIGURATION



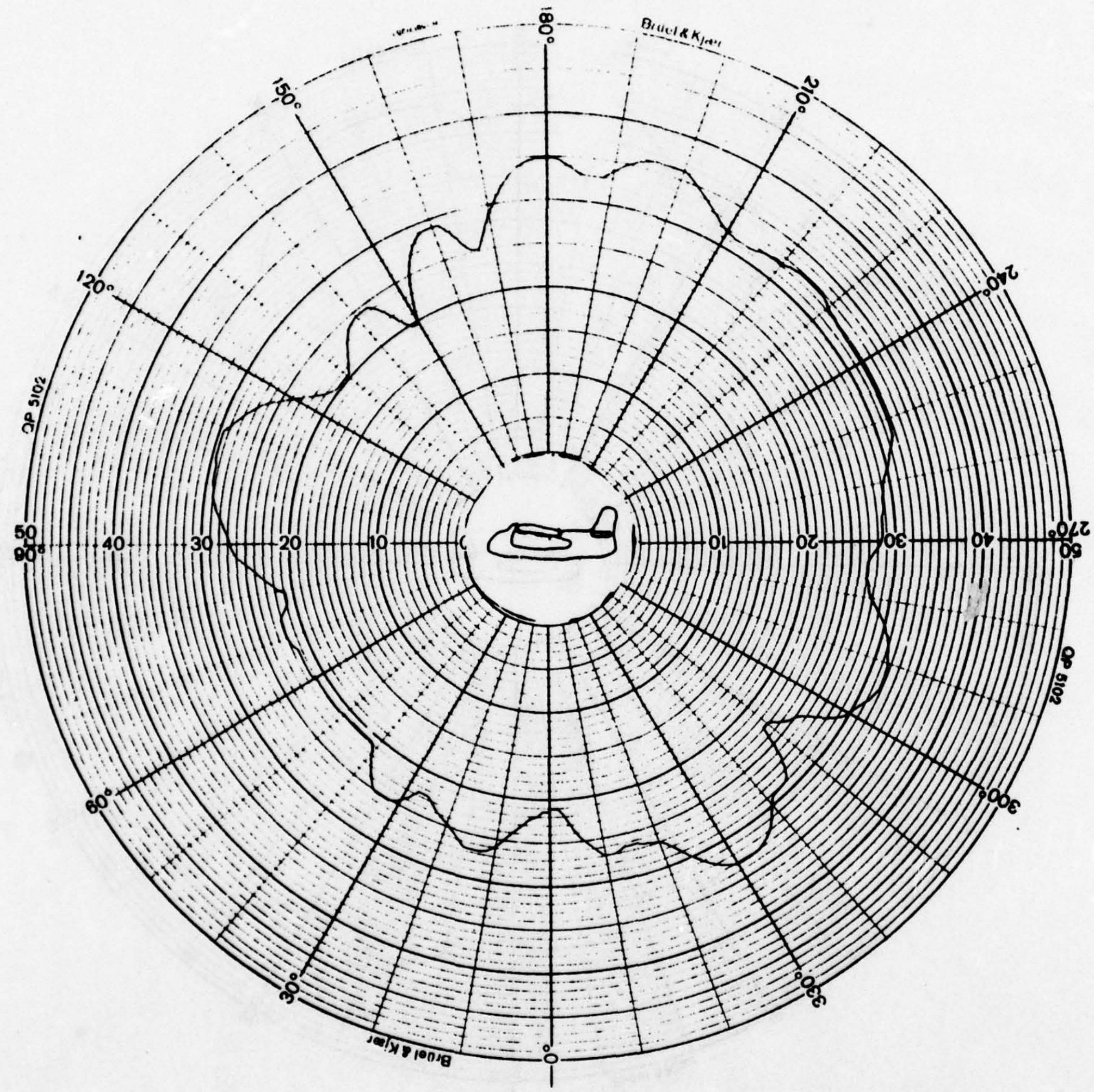
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 37 *POLARIZATION* E_θ ____ E_ϕ ✓
PATTERN PLANE *YAW* ✓ *PITCH* ____ *ROLL* ____
ANTENNA TYPE VOR-LOC
ANTENNA LOCATION WHIPS, TAILS AFT, STANDARD CONFIGURATION



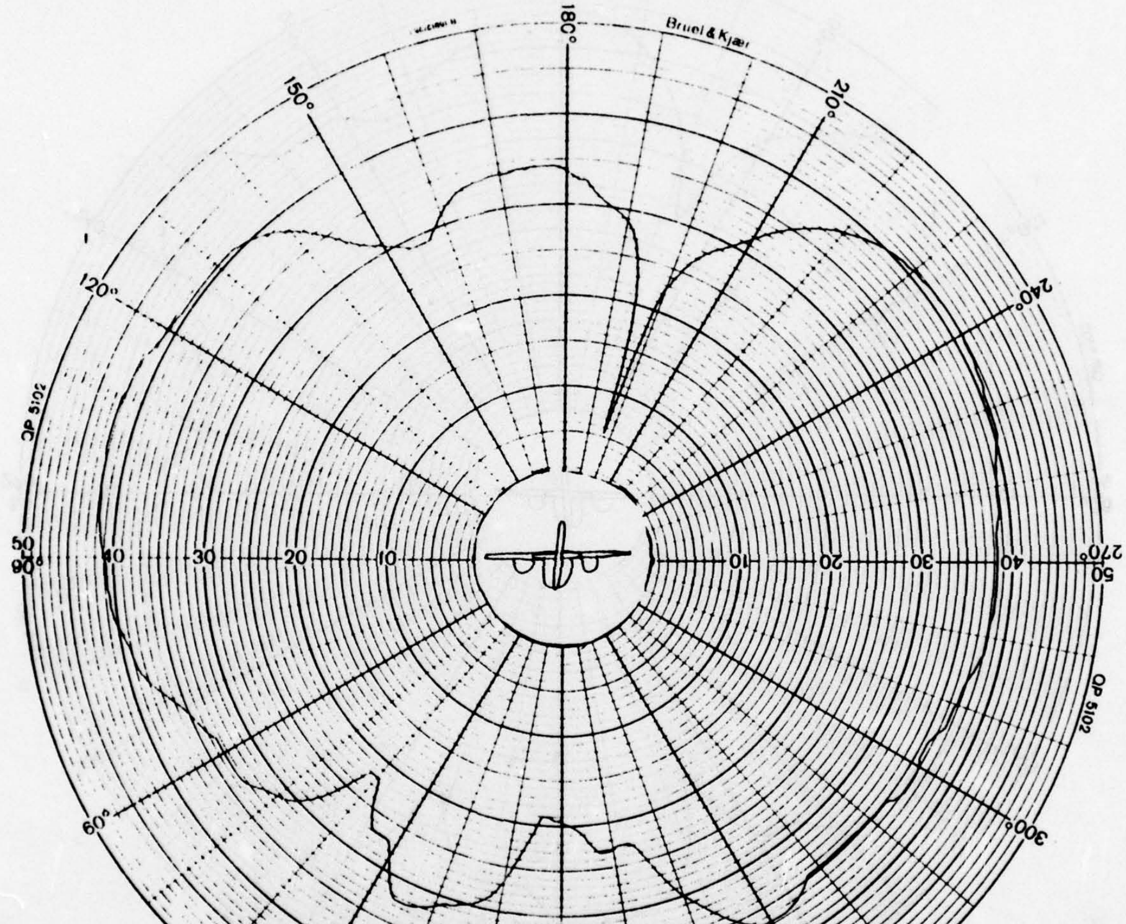
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 38 *POLARIZATION* E_θ ✓ E_ϕ ____
PATTERN PLANE YAW ✓ *PITCH* ____ *ROLL* ____
ANTENNA TYPE VOR-LOC
ANTENNA LOCATION WHIPS, TAILS AFT, STANDARD CONFIGURATION



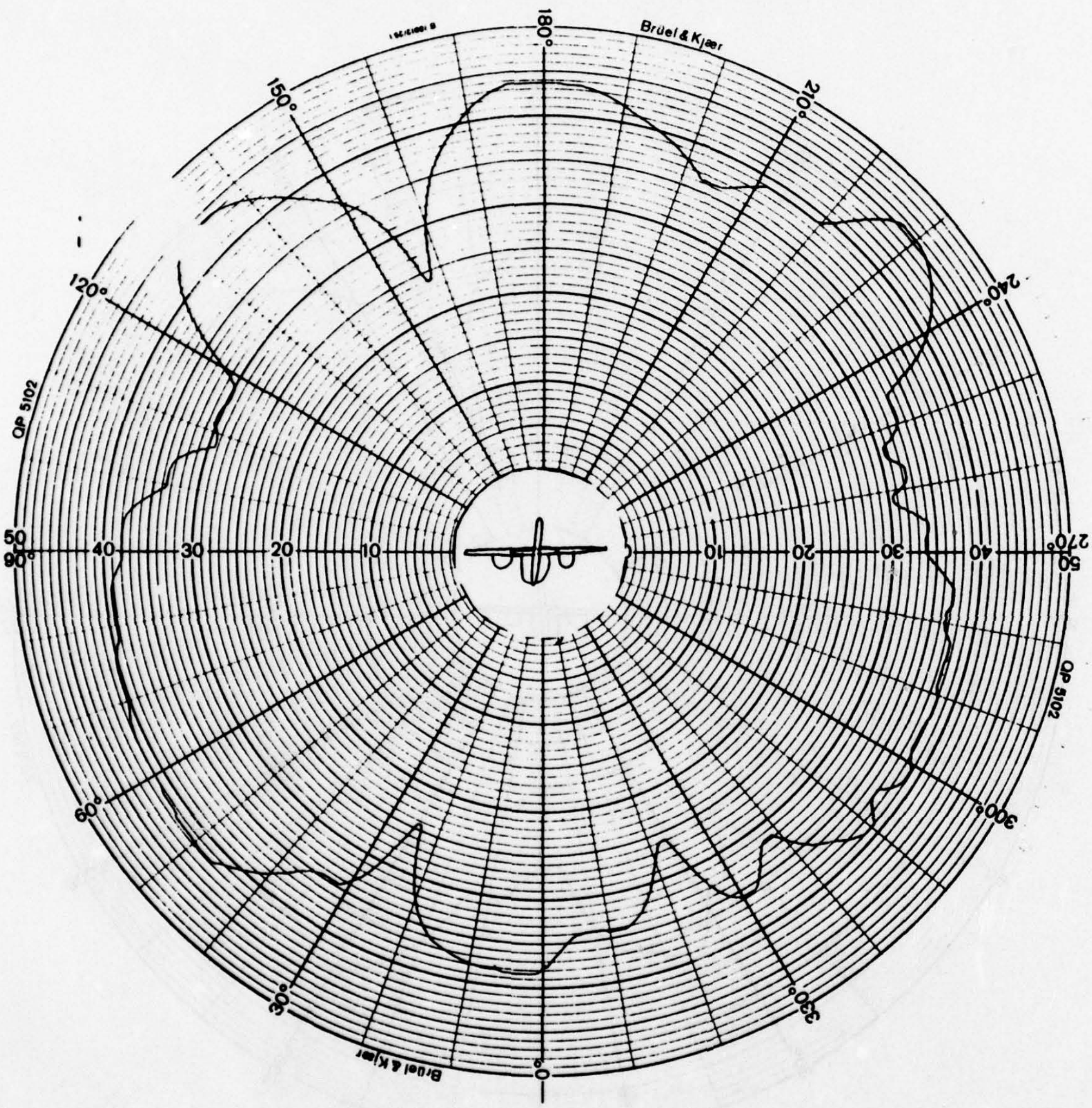
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 39 *POLARIZATION* E_Θ ___ E_ϕ ✓
PATTERN PLANE *YAW* ___ *PITCH* ✓ *ROLL* ___
ANTENNA TYPE VOR-LOC
ANTENNA LOCATION WHIPS, TAILS AFT, STANDARD CONFIGURATION



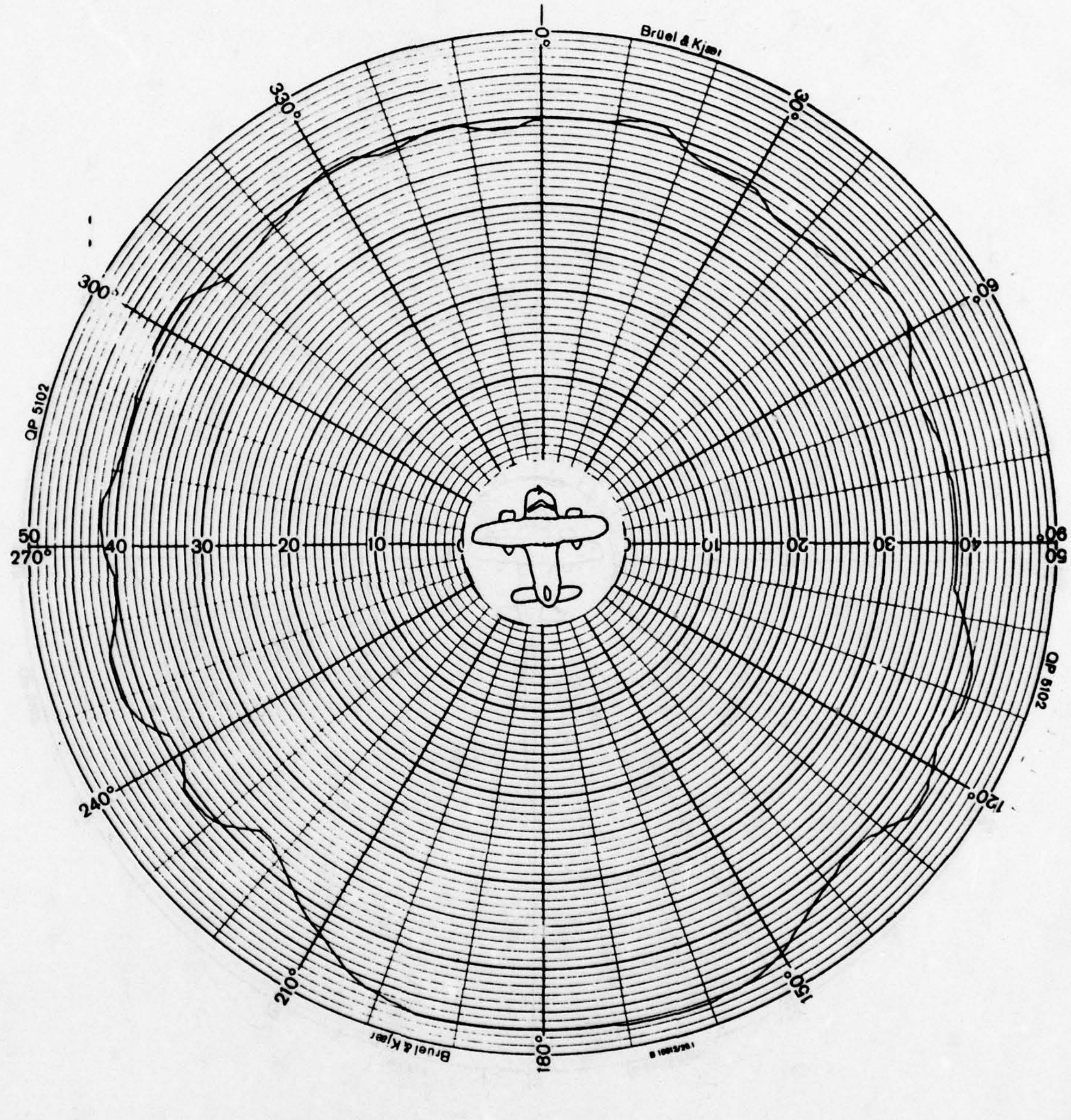
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 40 *POLARIZATION* E_Θ ✓ E_ϕ ___
PATTERN PLANE YAW ___ *PITCH* ✓ *ROLL* ___
ANTENNA TYPE VOR-LOC
ANTENNA LOCATION **WHIPS, TAILS AFT, STANDARD CONFIGURATION**



TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 41 *POLARIZATION* E_θ ___ E_ϕ ✓
PATTERN PLANE YAW ___ *PITCH* ___ *ROLL* ✓
ANTENNA TYPE VOR-LOC
ANTENNA LOCATION WHIPS, TAILS AFT, STANDARD CONFIGURATION



TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 42 *POLARIZATION* E_θ ✓ E_ϕ ___
PATTERN PLANE YAW ___ *PITCH* ___ *ROLL* ✓
ANTENNA TYPE VOR-LOC
ANTENNA LOCATION WHIPS, TAILS AFT, STANDARD MOUNTING



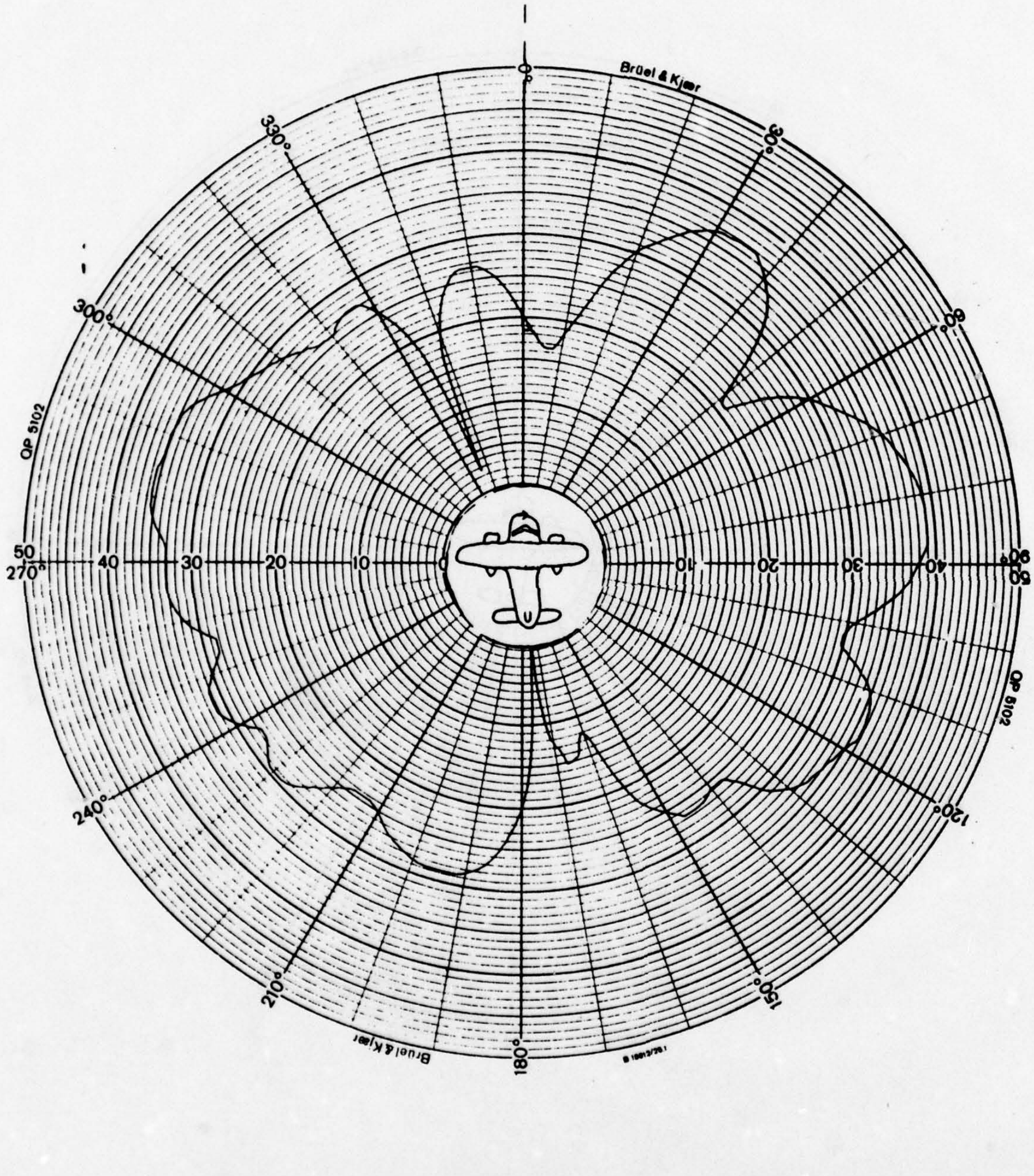
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)

PLOT NO. 43 *POLARIZATION* E_{θ} ____ E_{ϕ} ✓

PATTERN PLANE YAW ✓ *PITCH* ____ *ROLL* ____

ANTENNA TYPE VOR-LOC

ANTENNA LOCATION WHIPS, TAILS FORWARD, BASE AT LEADING EDGE



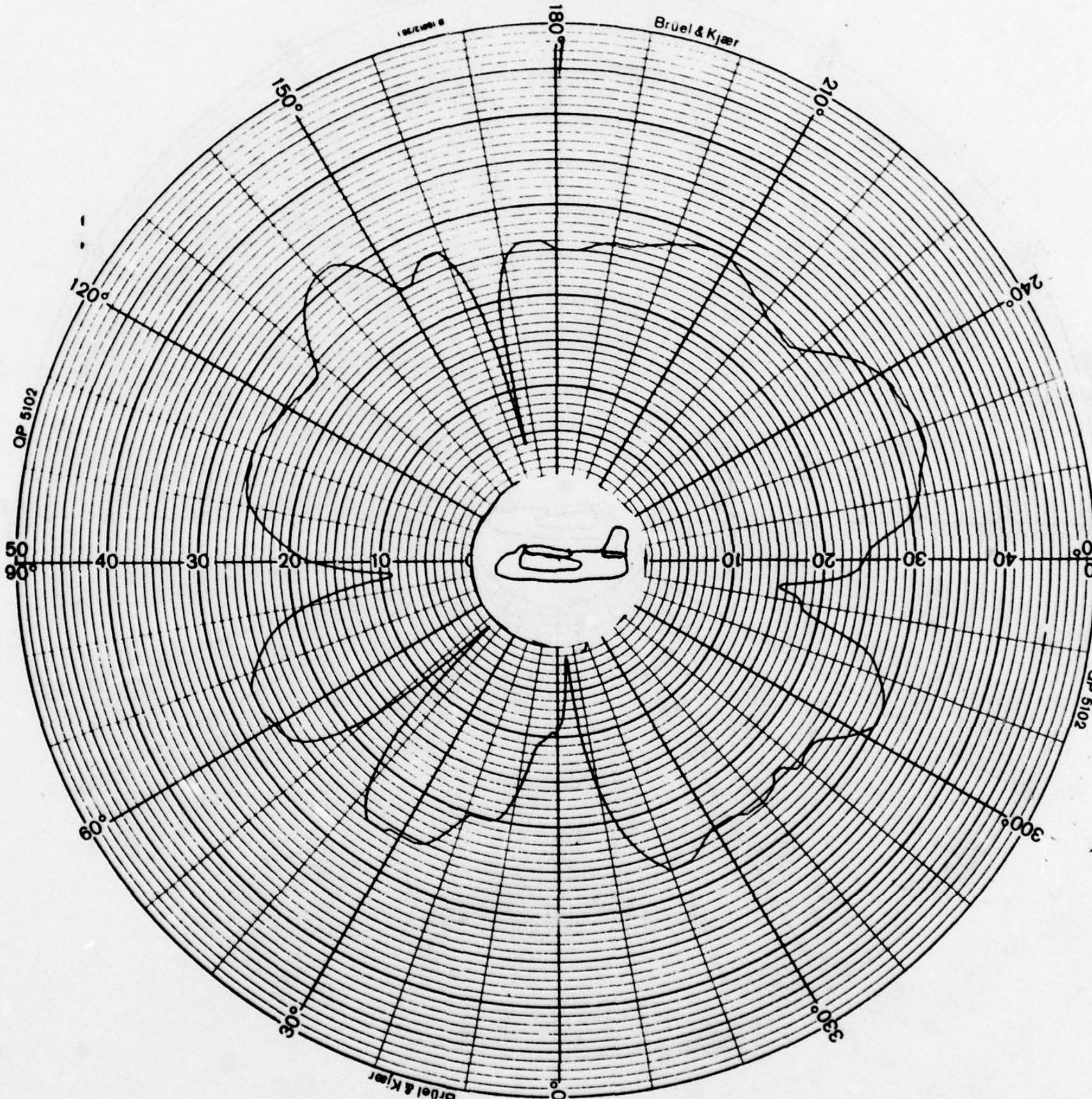
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)

PLOT NO. 44 *POLARIZATION* E_θ ✓ E_ϕ ____

PATTERN PLANE *YAW* ✓ *PITCH* ____ *ROLL* ___

ANTENNA TYPE VOR-LOC

ANTENNA LOCATION WHIPS, TAILS FORWARD, BASE AT LEADING EDGE



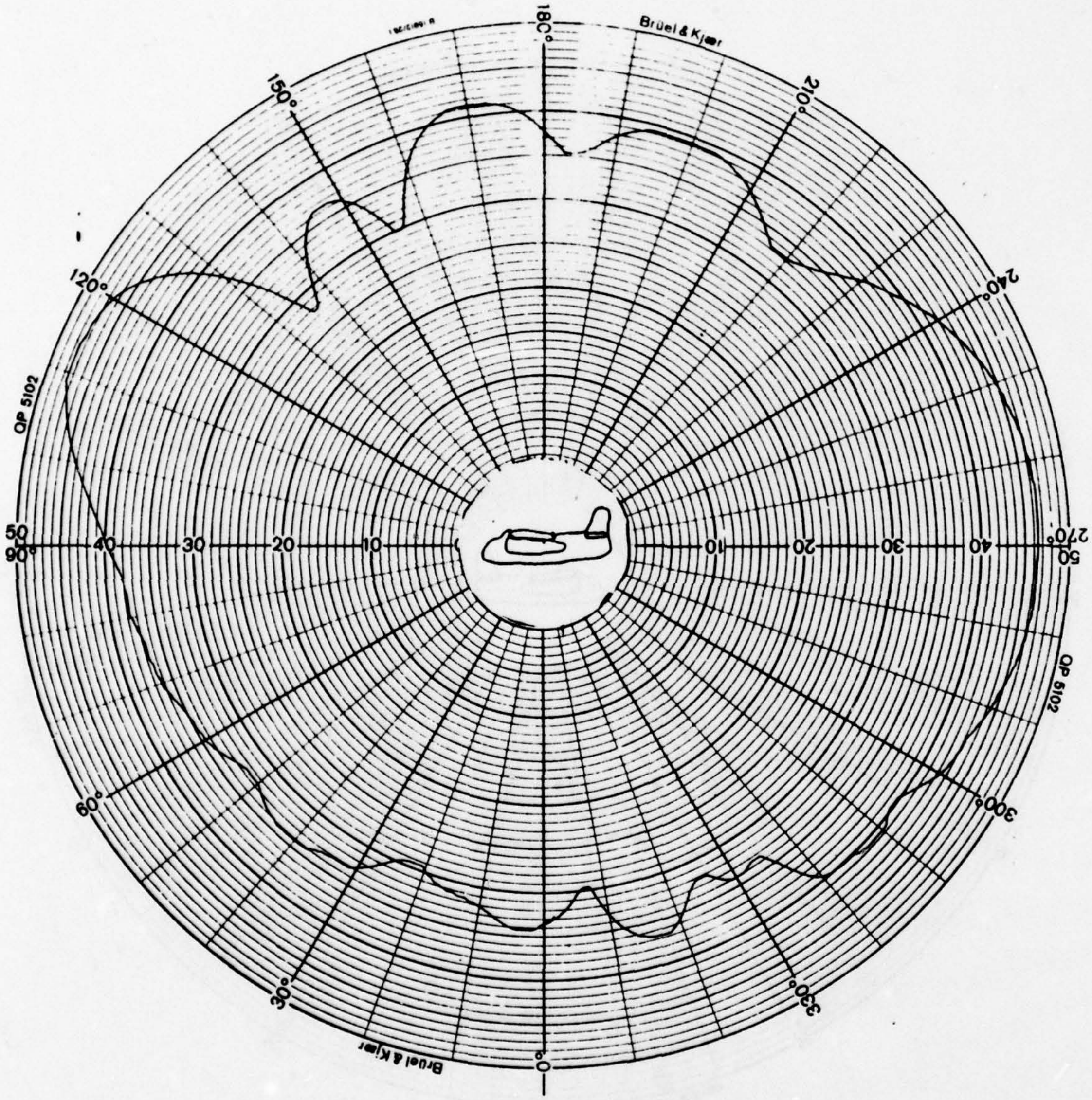
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)

PLOT NO. 45 *POLARIZATION* E_θ ✓ E_ϕ ____

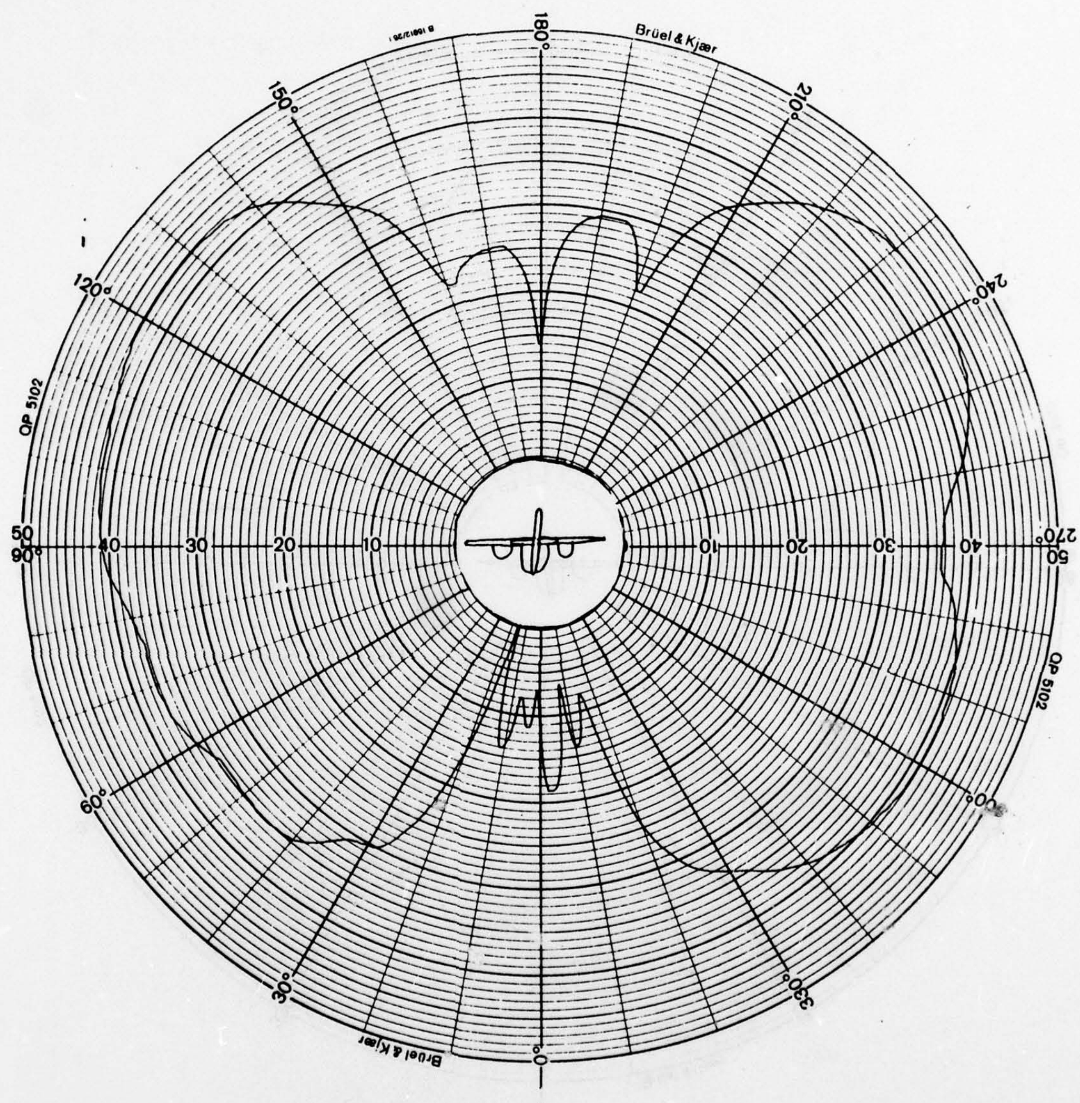
PATTERN PLANE YAW ____ *PITCH* ✓ *ROLL* ____

ANTENNA TYPE VOR-LOC

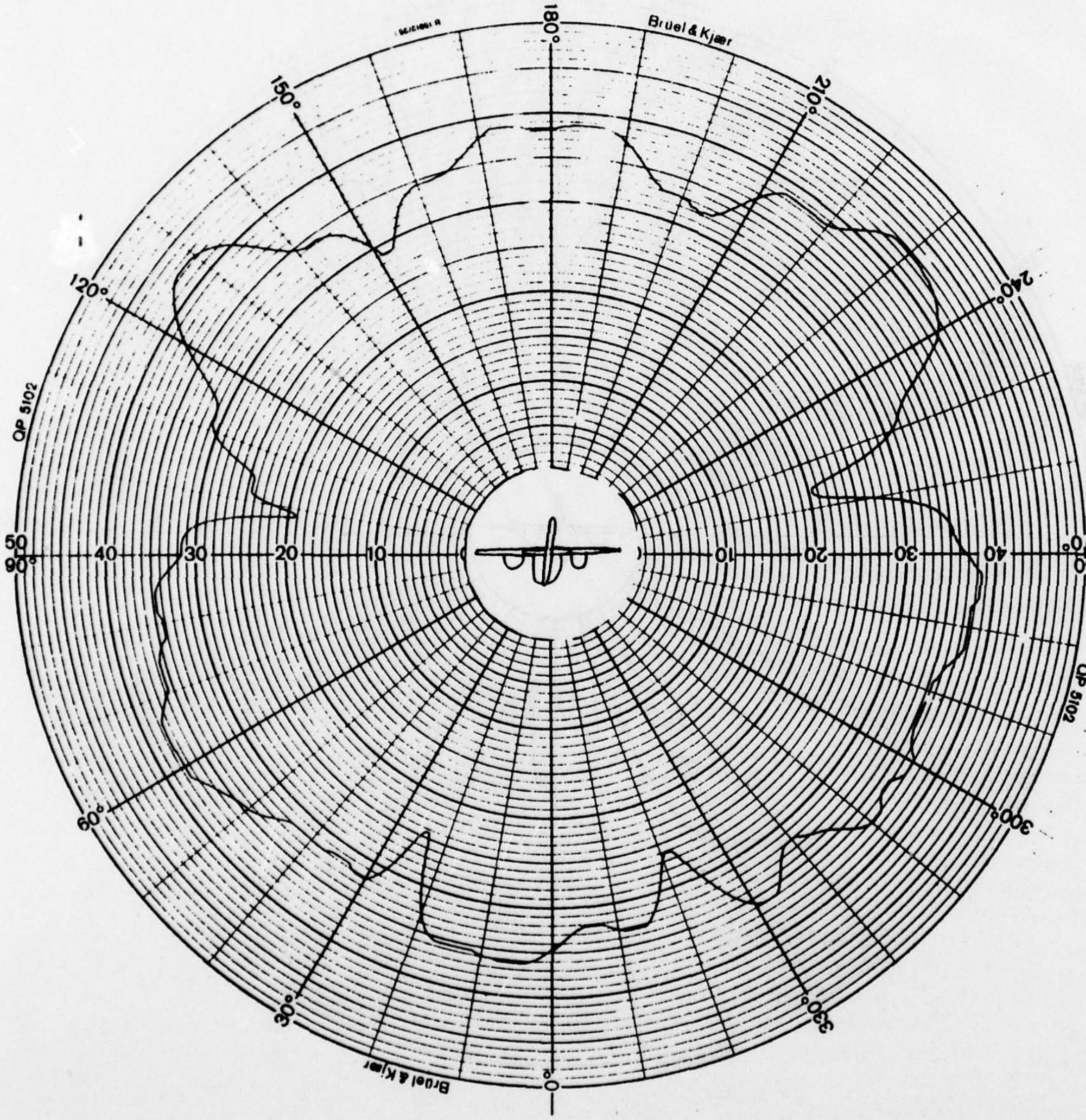
ANTENNA LOCATION WHIPS, TAILS FORWARD, BASE AT LEADING EDGE



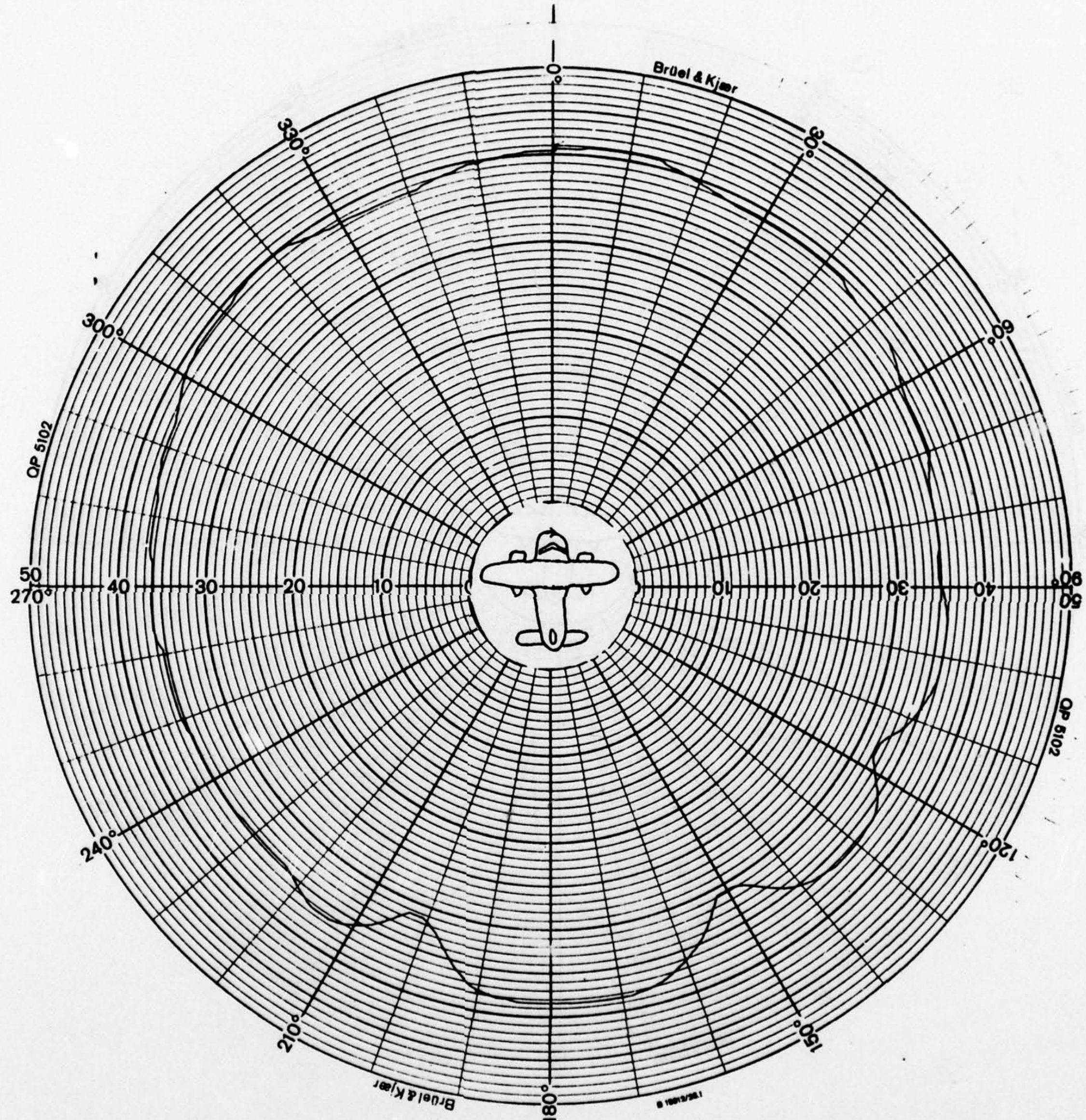
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 46 *POLARIZATION* E_θ ____ E_ϕ ✓
PATTERN PLANE YAW ____ *PITCH* ✓ *ROLL* ____
ANTENNA TYPE VOR-LOC
ANTENNA LOCATION WHIPS, TAILS FORWARD, BASE AT FRONT EDGE



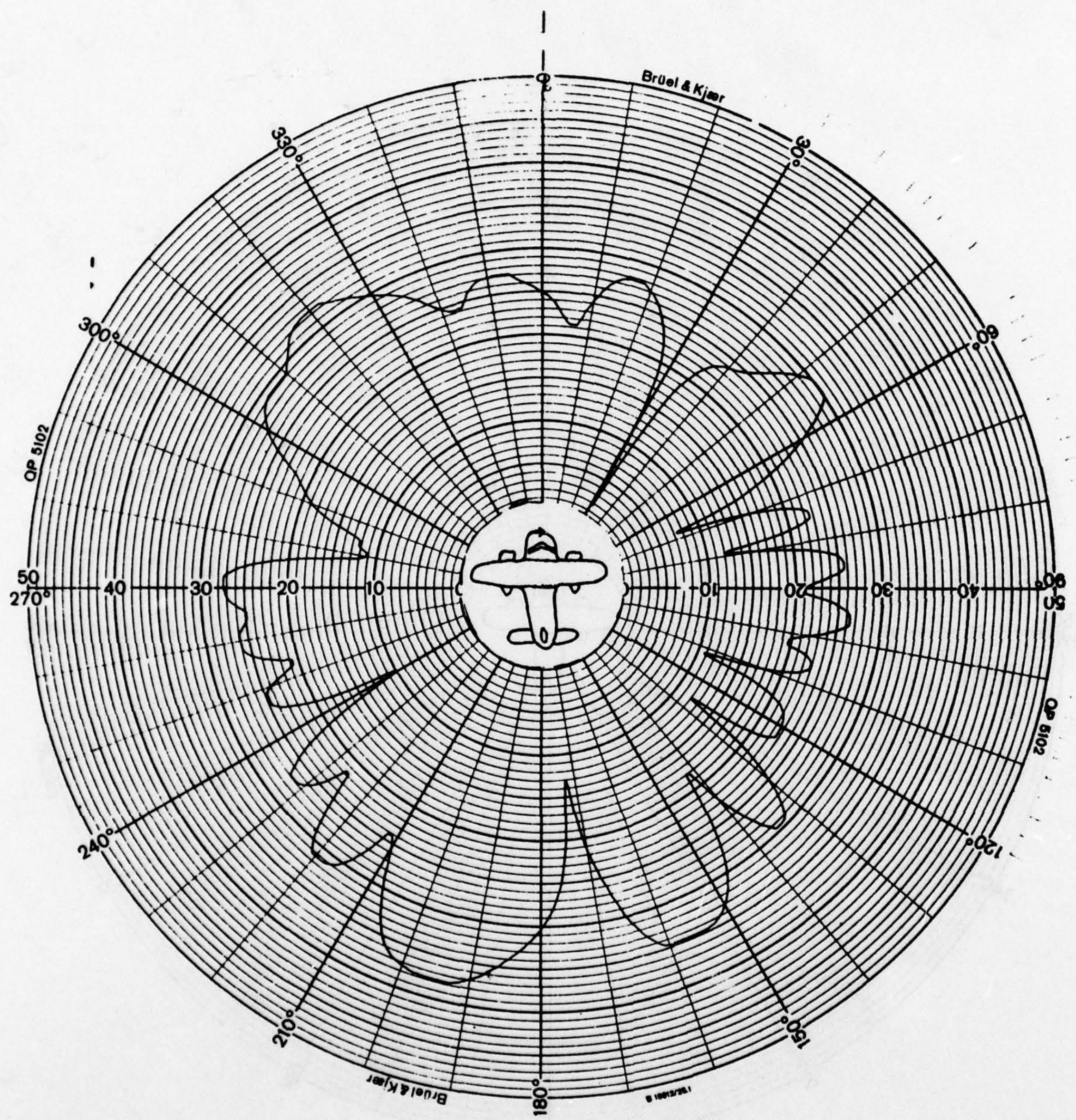
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 47 *POLARIZATION* E_θ ___ E_ϕ ✓
PATTERN PLANE *YAW* ___ *PITCH* ___ *ROLL* ✓
ANTENNA TYPE VOR-LOC
ANTENNA LOCATION WHIPS, TAILS FORWARD, BASE AT FRONT EDGE



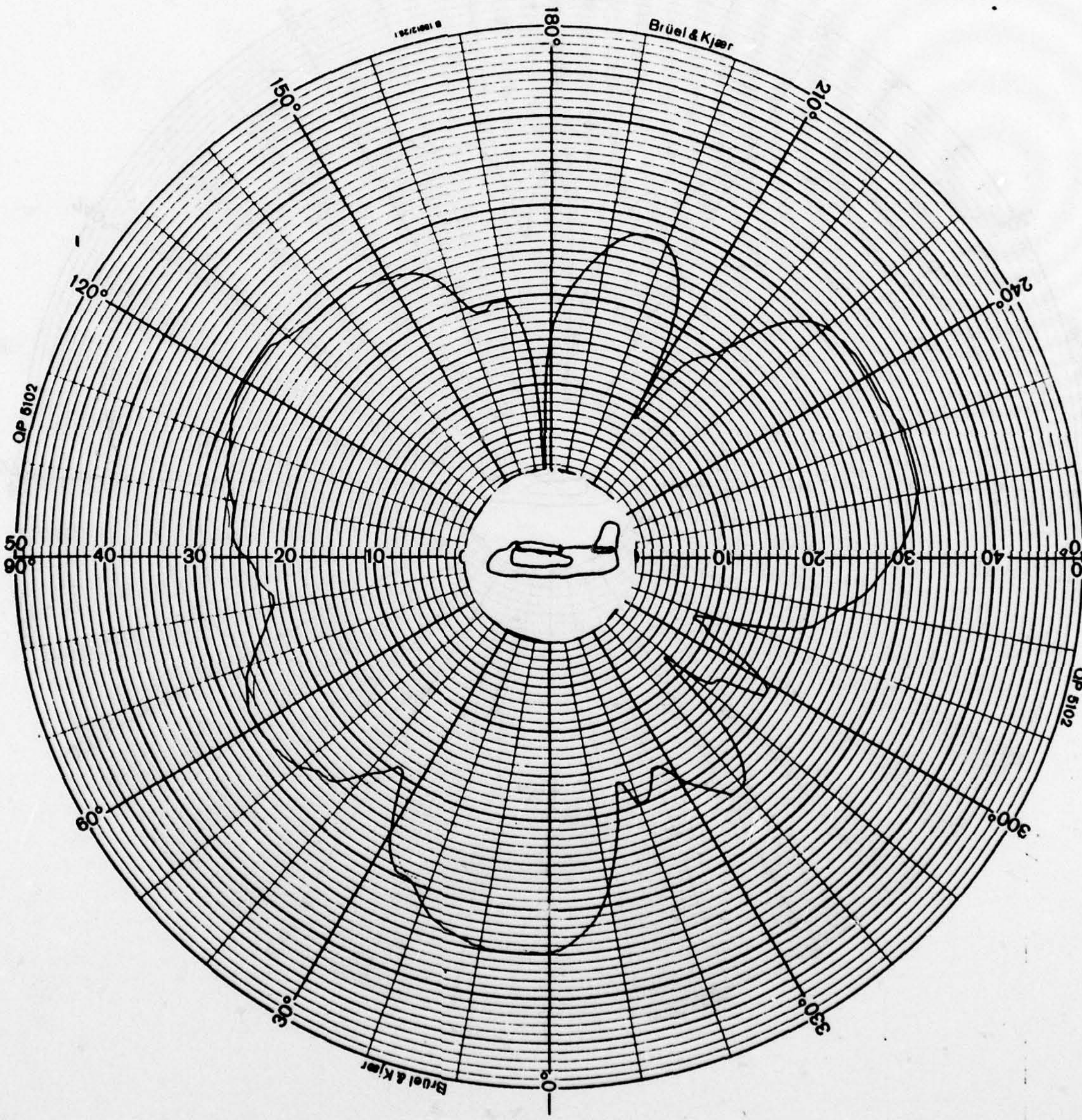
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 48 *POLARIZATION* E_θ ✓ E_ϕ ___
PATTERN PLANE *YAW* ___ *PITCH* ___ *ROLL* ✓
ANTENNA TYPE VOR-LOC
ANTENNA LOCATION WHIPS, TAILS FORWARD, BASE AT FRONT EDGE



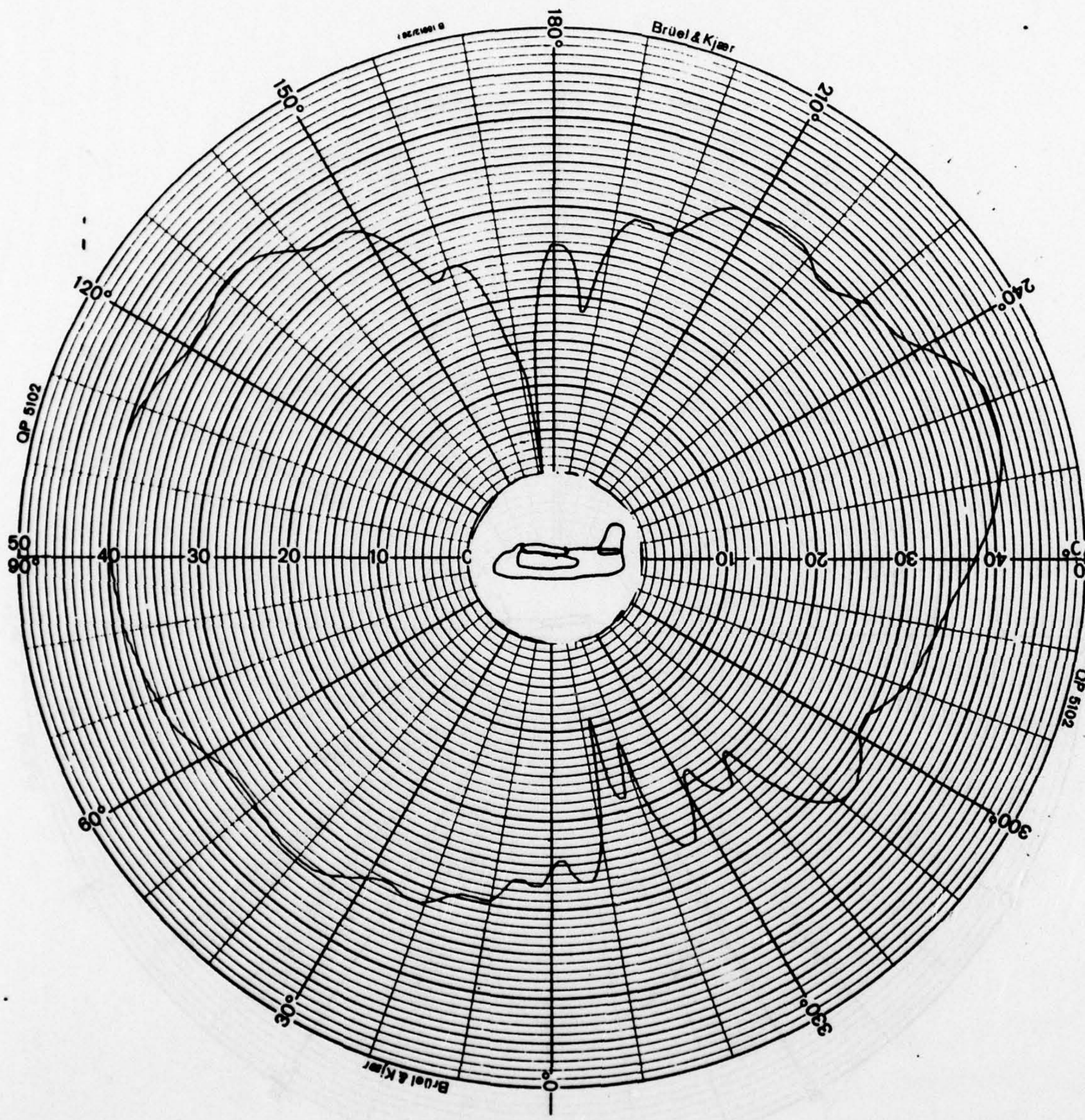
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 49 *POLARIZATION* E_θ ✓ E_ϕ ____
PATTERN PLANE YAW ✓ *PITCH* ____ *ROLL* ____
ANTENNA TYPE VHF-AM
ANTENNA LOCATION BELLY-FORWARD COD POSITION



TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 50 *POLARIZATION* E_Θ ____ $E_\emptyset$ ✓
PATTERN PLANE YAW ✓ *PITCH* ____ *ROLL* ____
ANTENNA TYPE VHF-AM
ANTENNA LOCATION BELLY-FORWARD COD POSITION



TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 51 *POLARIZATION* E_θ ____ E_ϕ ✓
PATTERN PLANE YAW ____ *PITCH* ✓ *ROLL* ____
ANTENNA TYPE VHF-AM
ANTENNA LOCATION BELLY-FORWARD COD POSITION



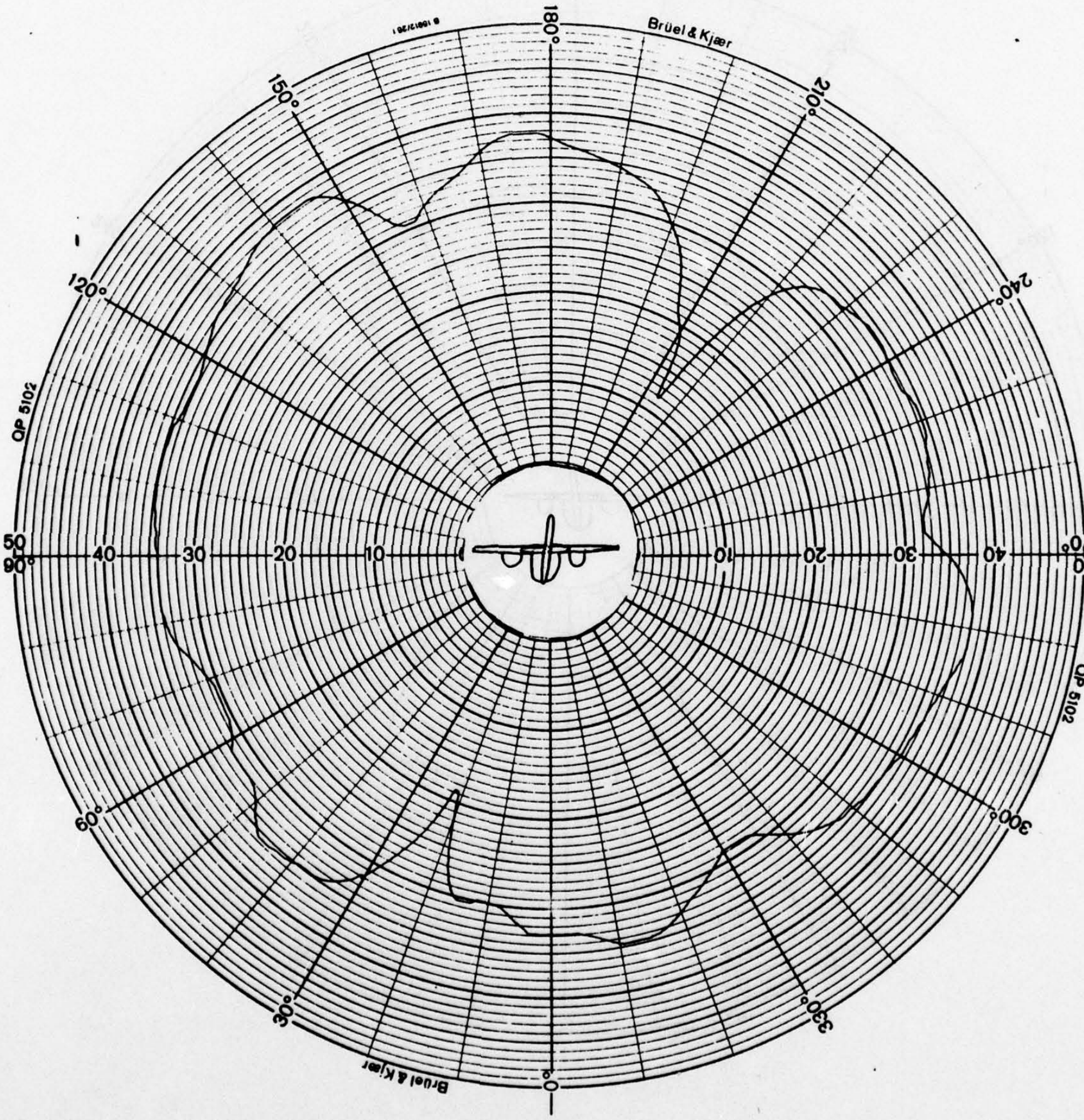
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)

PLOT NO. 52 *POLARIZATION* E_θ ✓ E_ϕ ___

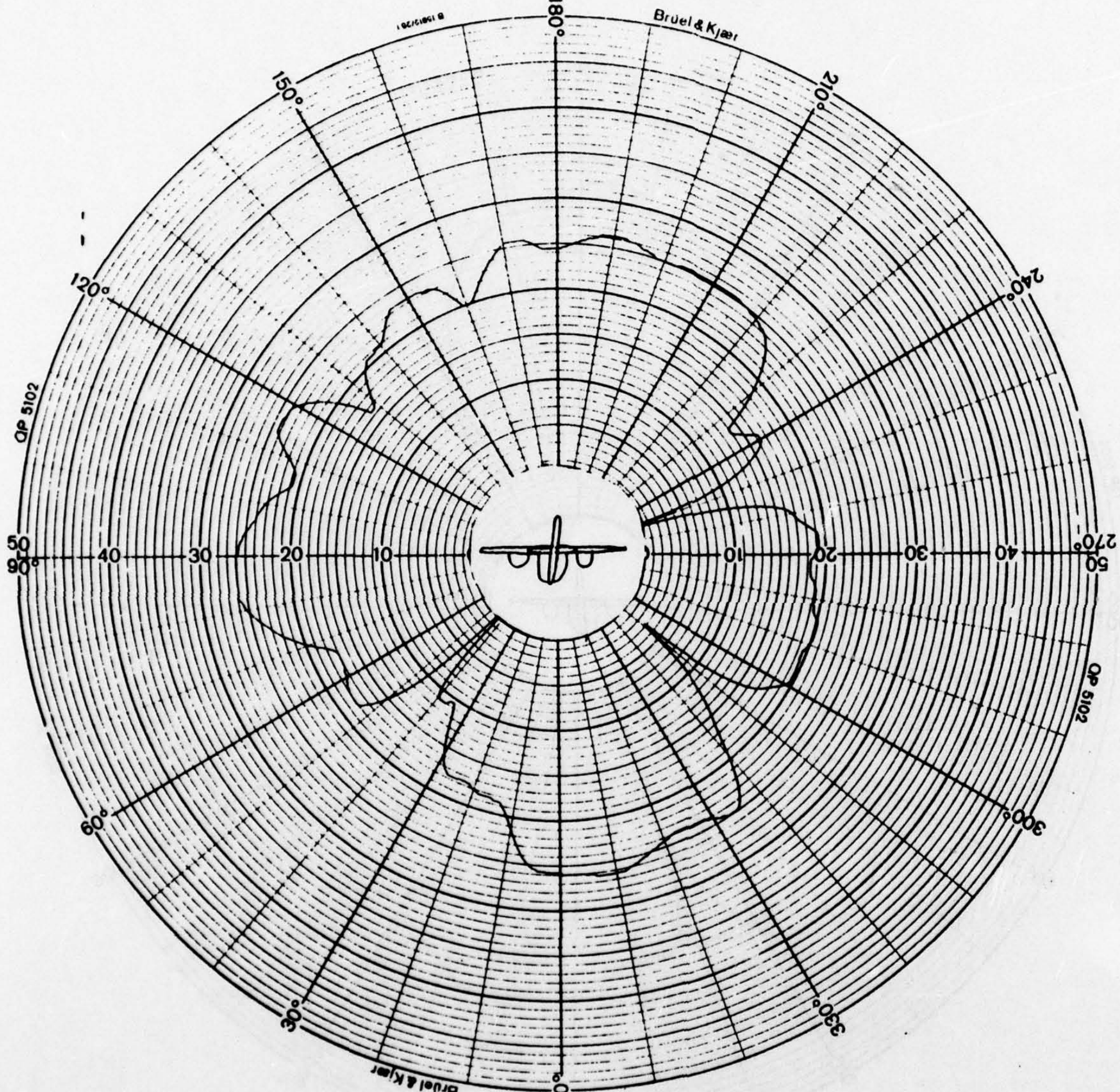
PATTERN PLANE YAW ___ *PITCH* ✓ *ROLL* ___

ANTENNA TYPE **VHF-AM**

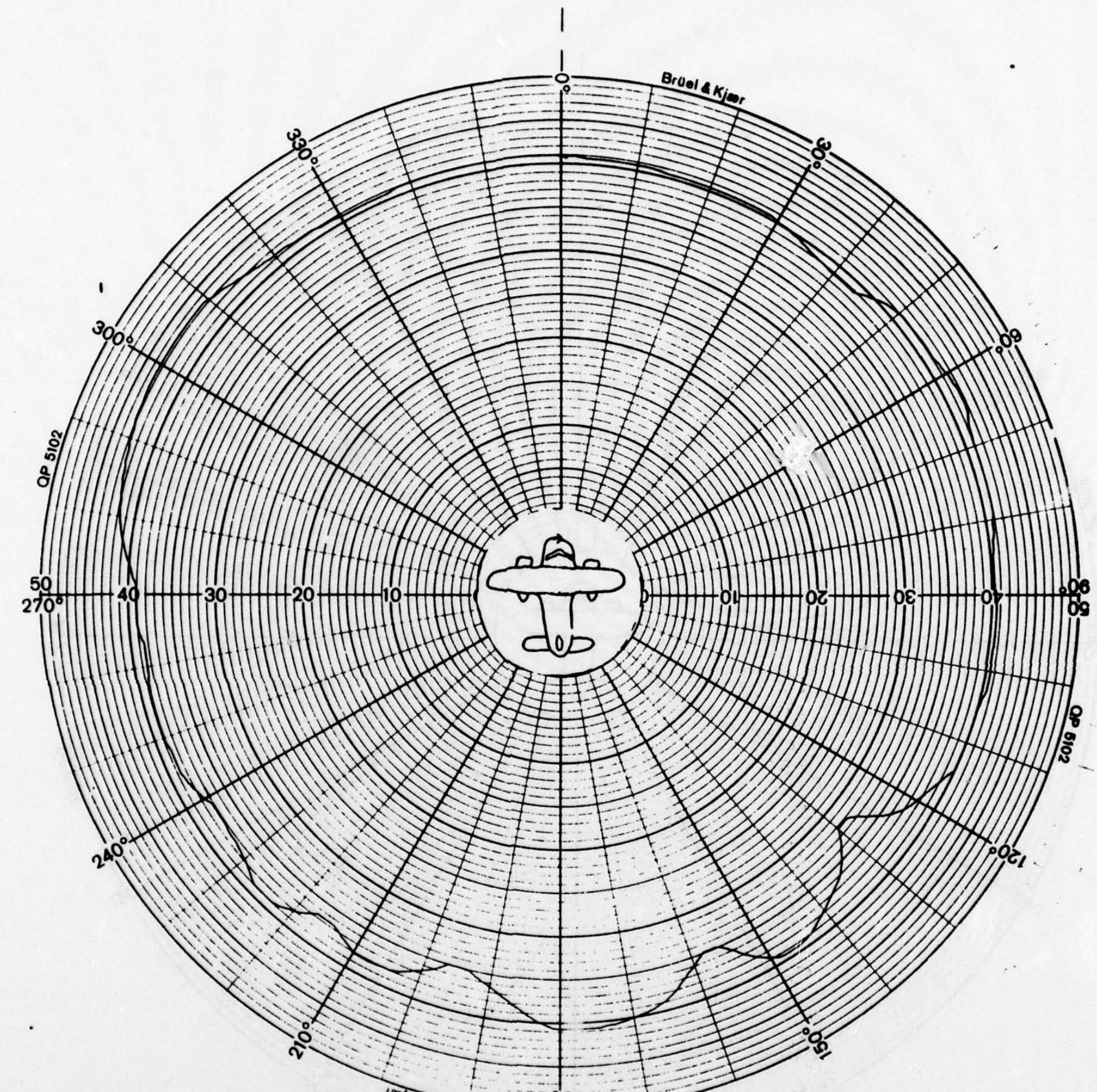
ANTENNA LOCATION **BELLY-FORWARD COD POSITION**



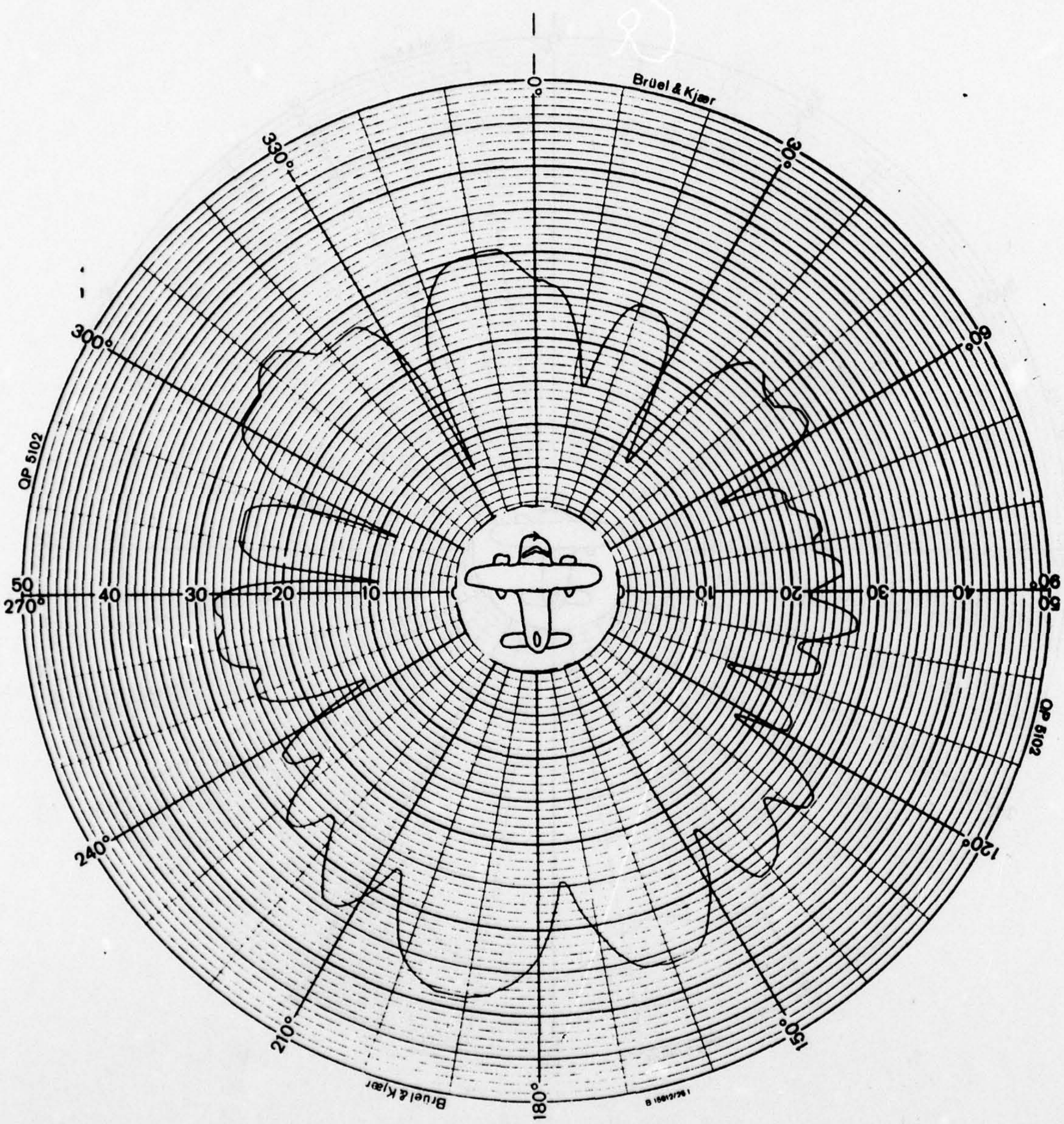
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 53 *POLARIZATION* E_θ ✓ E_ϕ ___
PATTERN PLANE *YAW* ___ *PITCH* ___ *ROLL* ✓
ANTENNA TYPE VHF-AM
ANTENNA LOCATION BELLY-FORWARD COD POSITION



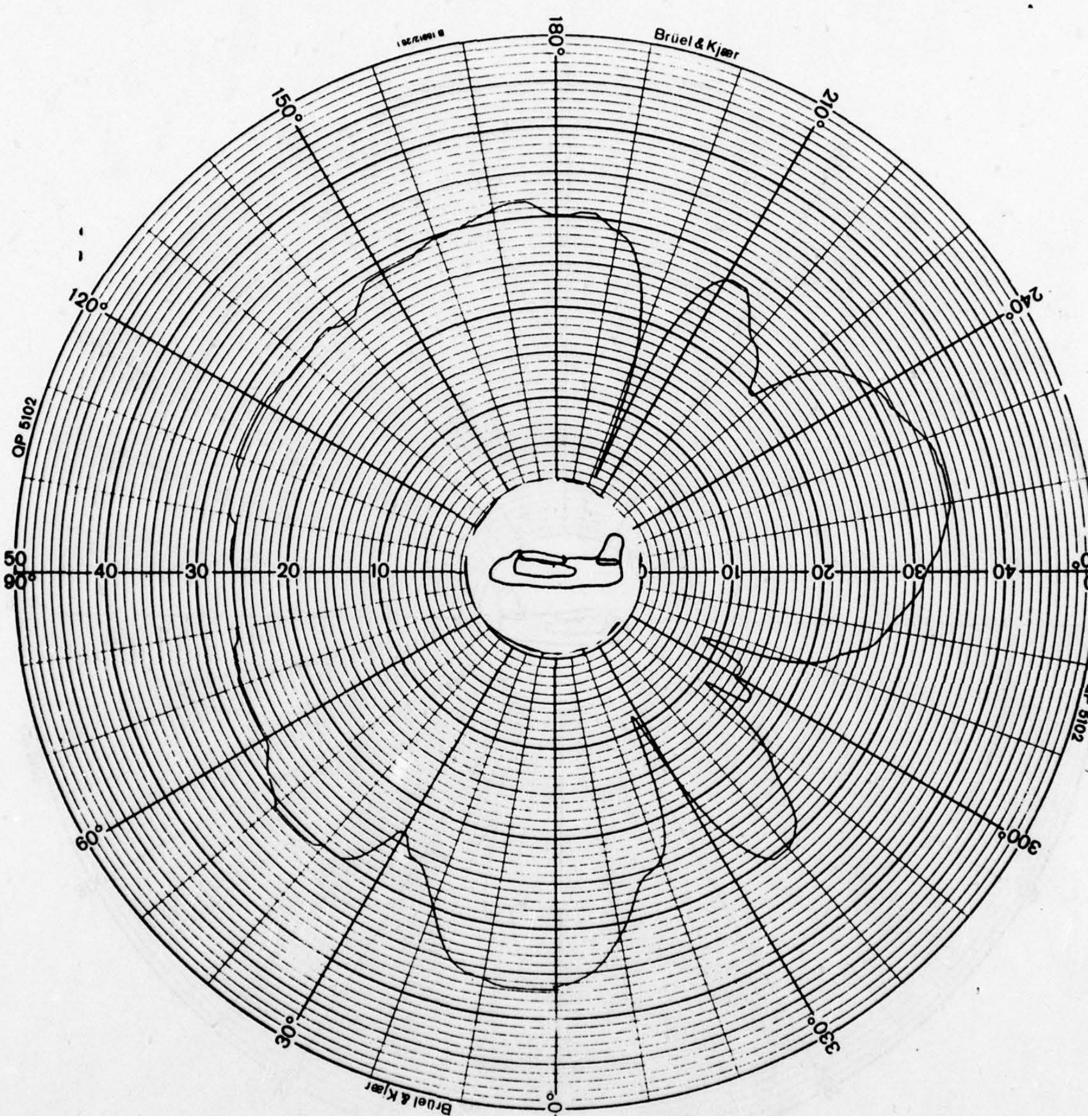
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 54 *POLARIZATION* E_θ ___ E_ϕ ✓
PATTERN PLANE YAW ___ *PITCH* ___ *ROLL* ✓
ANTENNA TYPE VHF-AM
ANTENNA LOCATION BELLY-FORWARD COD POSITION



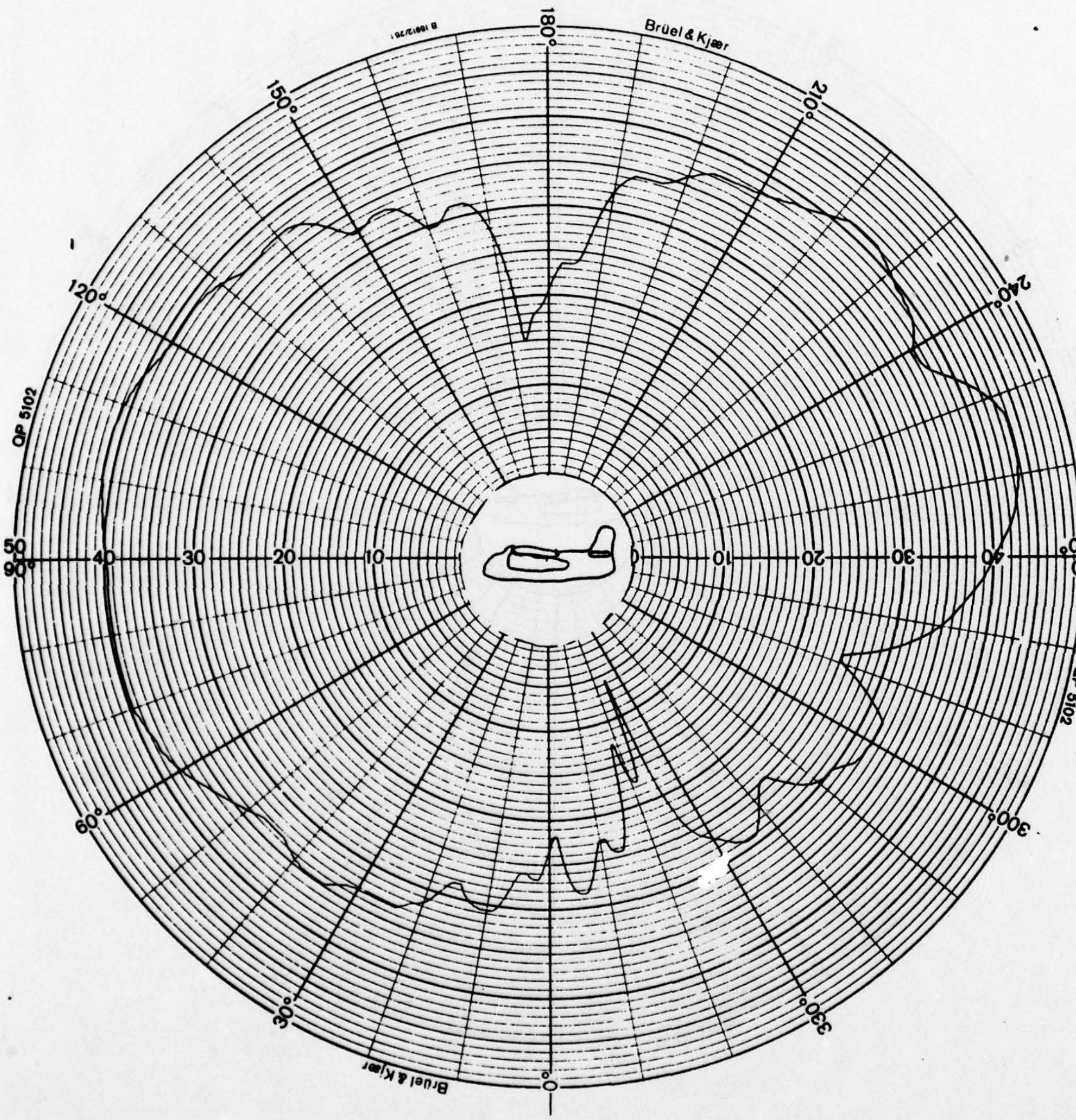
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 55 *POLARIZATION* E_{θ} ✓ E_{ϕ} ____
PATTERN PLANE *YAW* ✓ *PITCH* ____ *ROLL* ____
ANTENNA TYPE VHF-FM
ANTENNA LOCATION BELLY-FORWARD COD POSITION



TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 56 *POLARIZATION* E_Θ ___ E_ϕ ✓
PATTERN PLANE *YAW* ✓ *PITCH* ___ *ROLL* ___
ANTENNA TYPE VHF-FM
ANTENNA LOCATION BELLY-FORWARD COD POSITION



TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 57 *POLARIZATION* E_Θ ____ $E_\emptyset$ ✓
PATTERN PLANE YAW ____ *PITCH* ✓ *ROLL* ____
ANTENNA TYPE VHF-FM
ANTENNA LOCATION BELLY-FORWARD COD POSITION



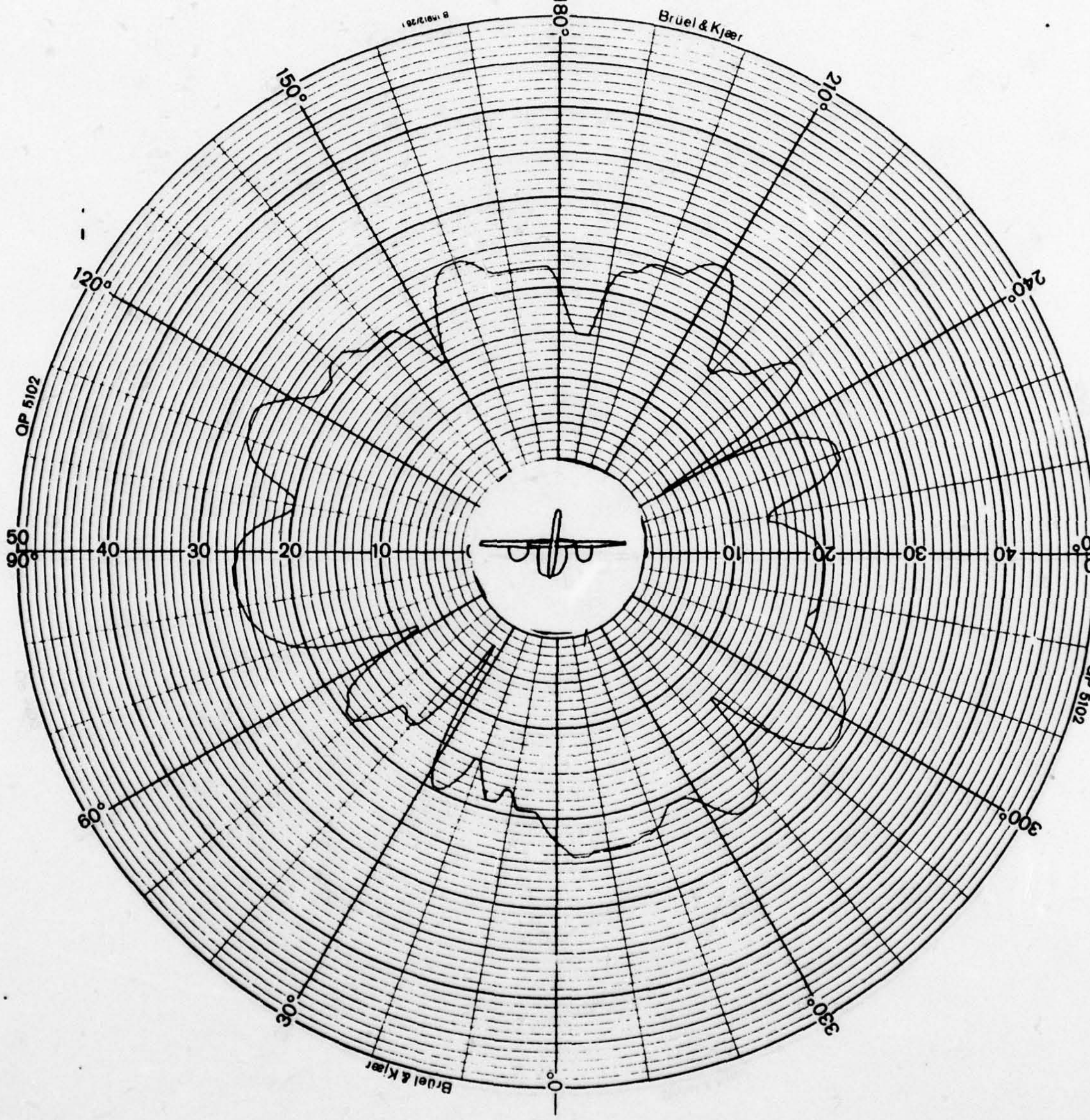
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)

PLOT NO. 58 *POLARIZATION* E_θ ✓ E_ϕ ____

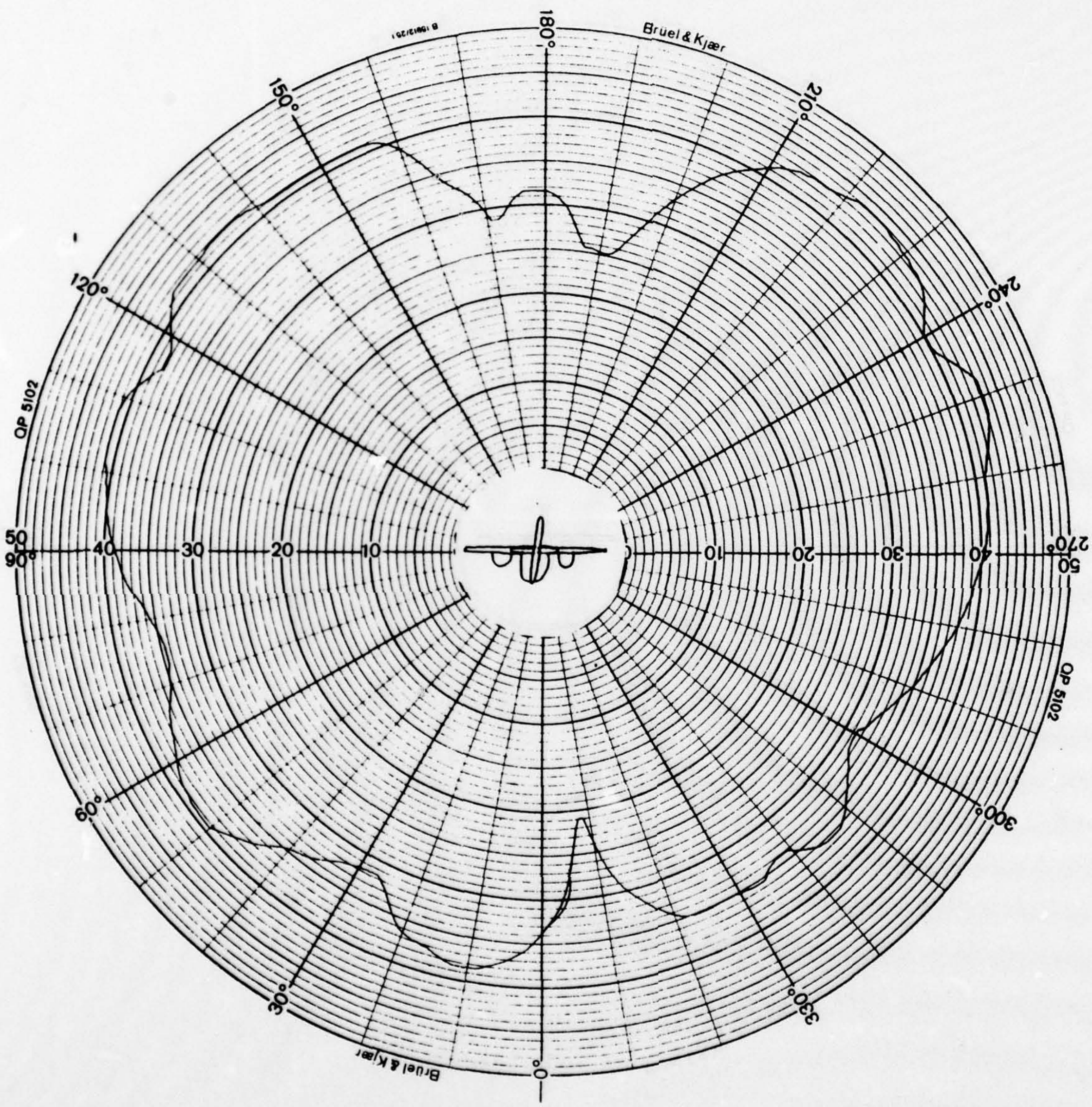
PATTERN PLANE YAW ____ *PITCH* ✓ *ROLL* ____

ANTENNA TYPE VHF-FM

ANTENNA LOCATION BELLY-FORWARD COD POSITION



TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 59 *POLARIZATION* E_Θ ___ E_ϕ ✓
PATTERN PLANE YAW ___ *PITCH* ___ *ROLL* ✓
ANTENNA TYPE VHF-FM
ANTENNA LOCATION BELLY-FORWARD COD POSITION



TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 60 *POLARIZATION* E_{Θ} ✓ E_{ϕ} ___
PATTERN PLANE YAW ___ *PITCH* ___ *ROLL* ✓
ANTENNA TYPE VHF-FM
ANTENNA LOCATION BELLY-FORWARD COD POSITION

AD-A059 026 DEFENCE RESEARCH ESTABLISHMENT OTTAWA (ONTARIO) F/G 17/9
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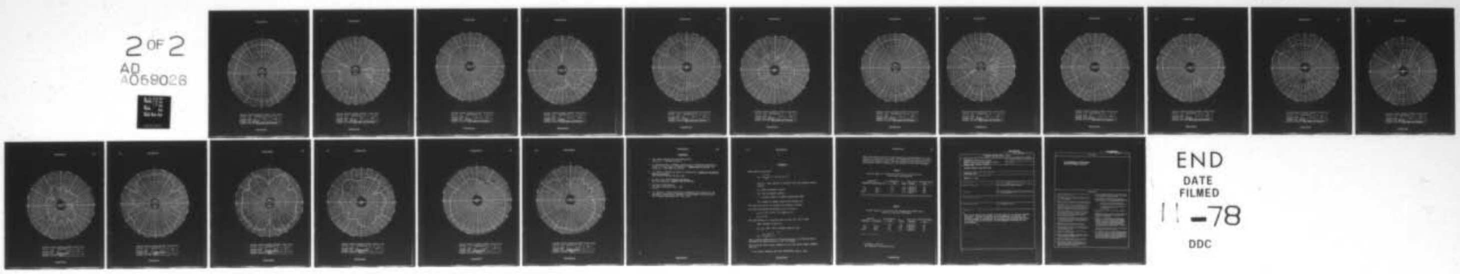

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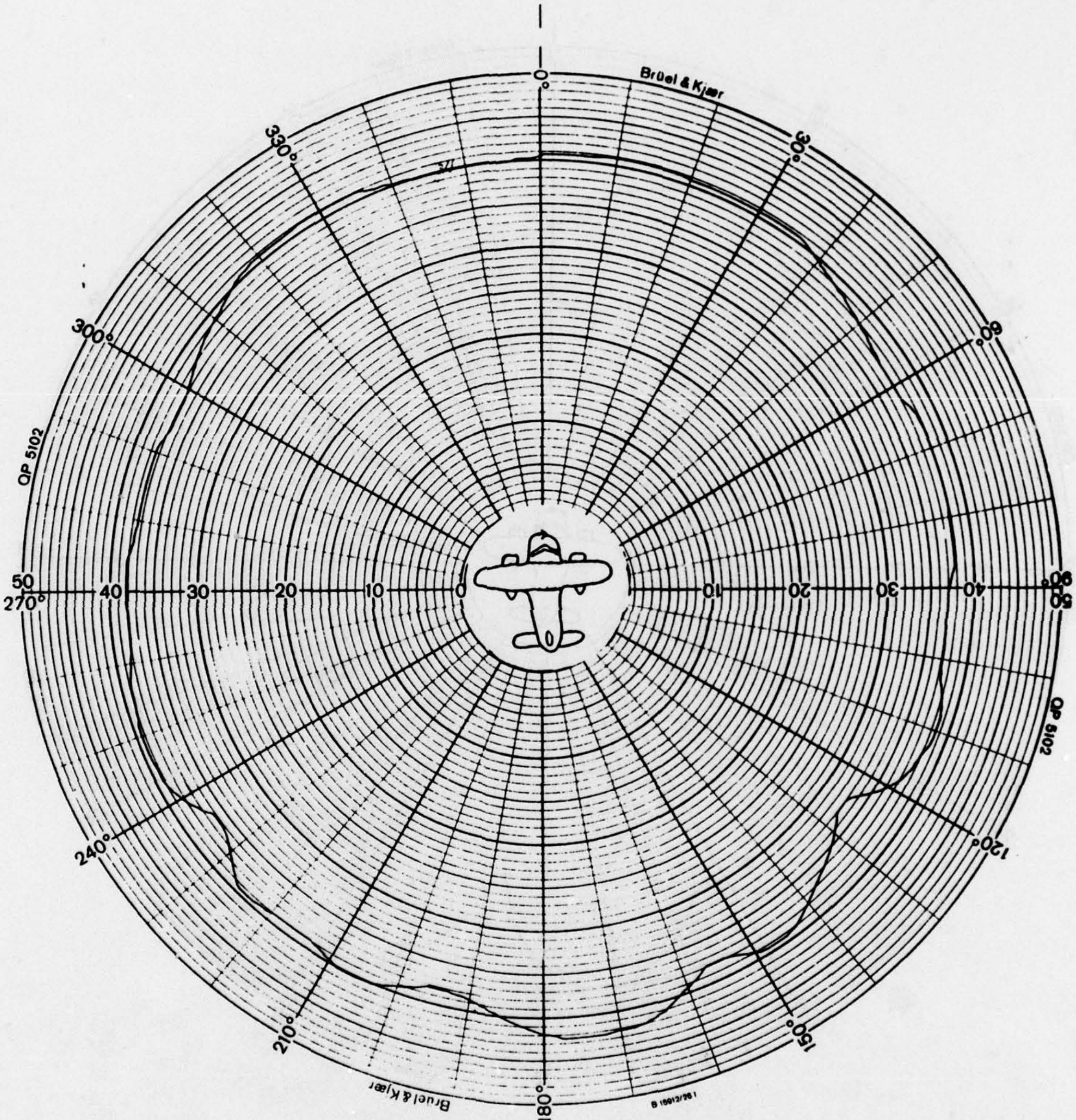
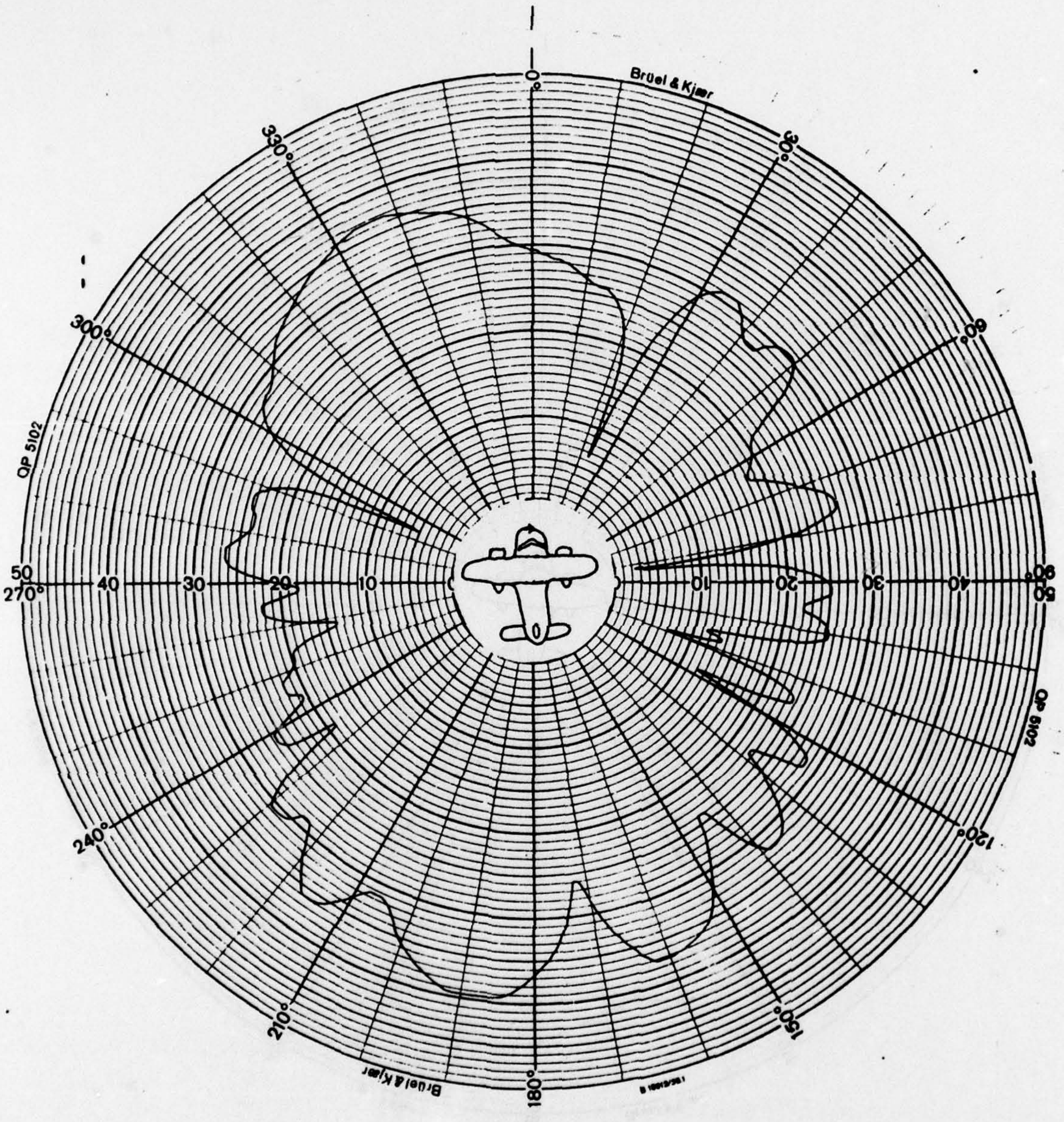
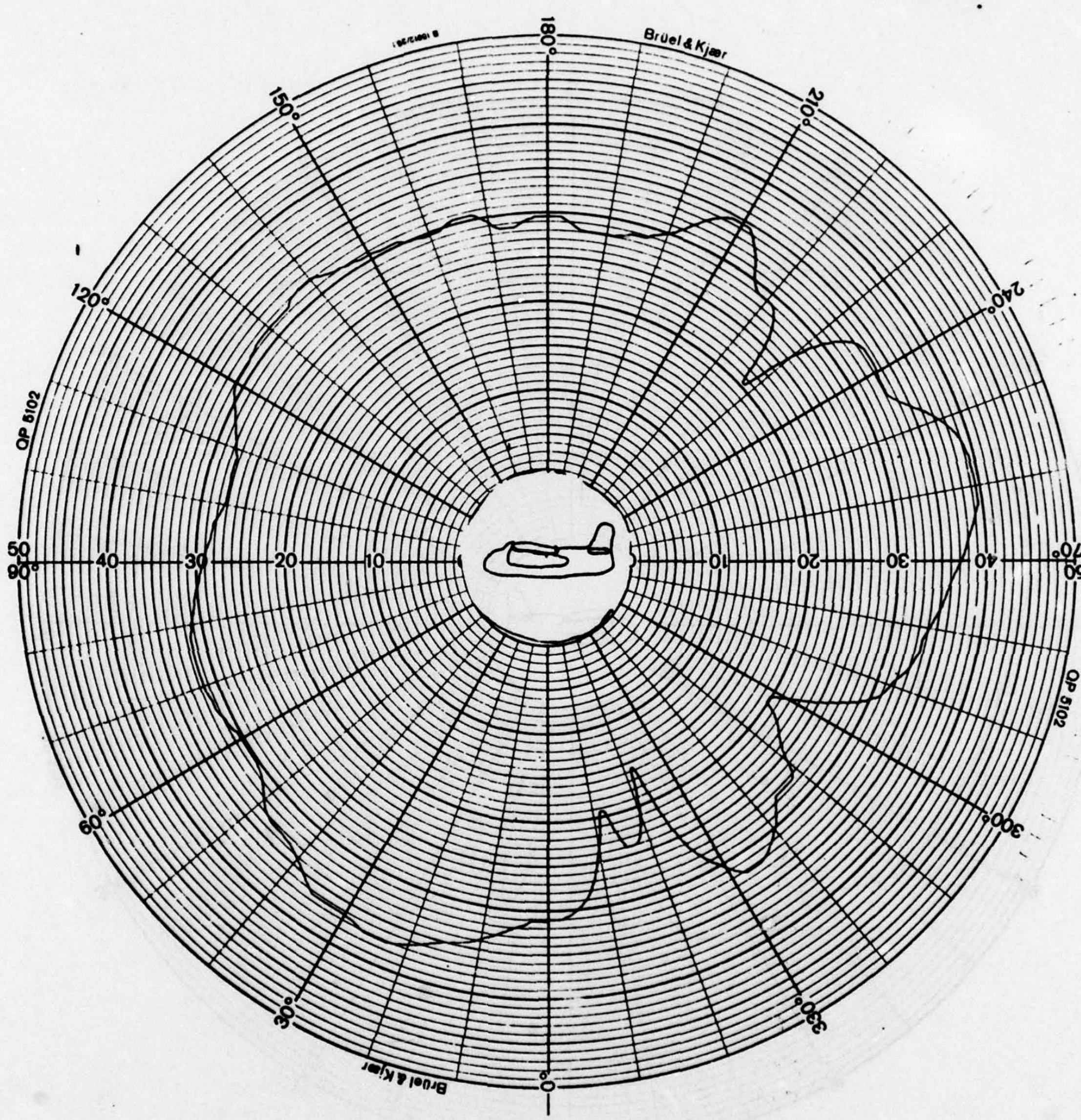


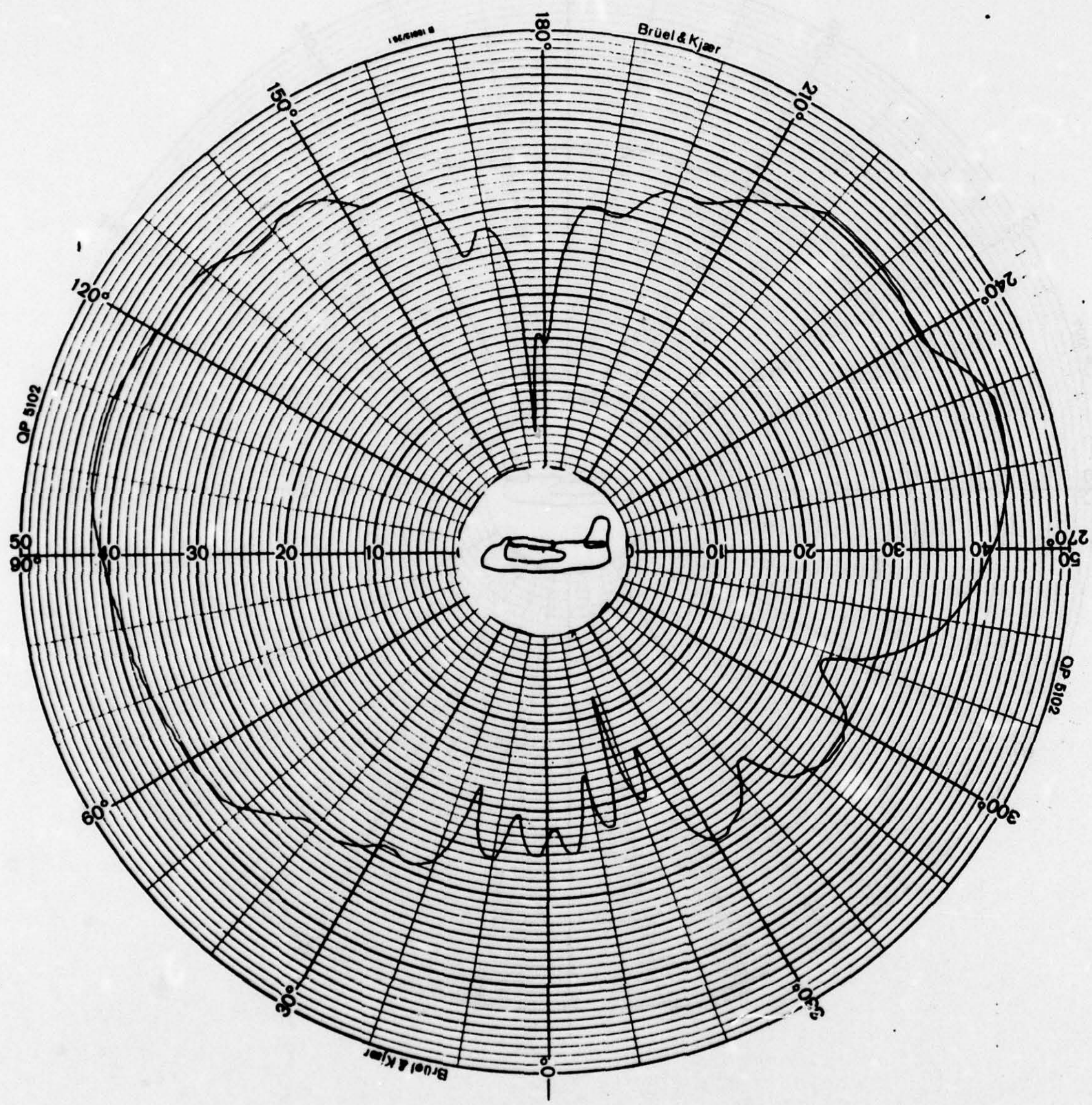
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 61 *POLARIZATION* E_θ ✓ E_ϕ ____
PATTERN PLANE YAW ✓ *PITCH* ____ *ROLL* ____
ANTENNA TYPE VHF-FM
ANTENNA LOCATION BELLY-REAR COD POSITION



TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 62 *POLARIZATION* E_θ ___ E_ϕ ✓
PATTERN PLANE YAW ✓ *PITCH* ___ *ROLL* ___
ANTENNA TYPE VHF-FM
ANTENNA LOCATION BELLY-REAR COD POSITION



TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 63 *POLARIZATION* E_θ ___ E_ϕ ✓
PATTERN PLANE YAW ___ *PITCH* ✓ *ROLL* ___
ANTENNA TYPE VHF-FM
ANTENNA LOCATION BELLY-REAR COD POSITION



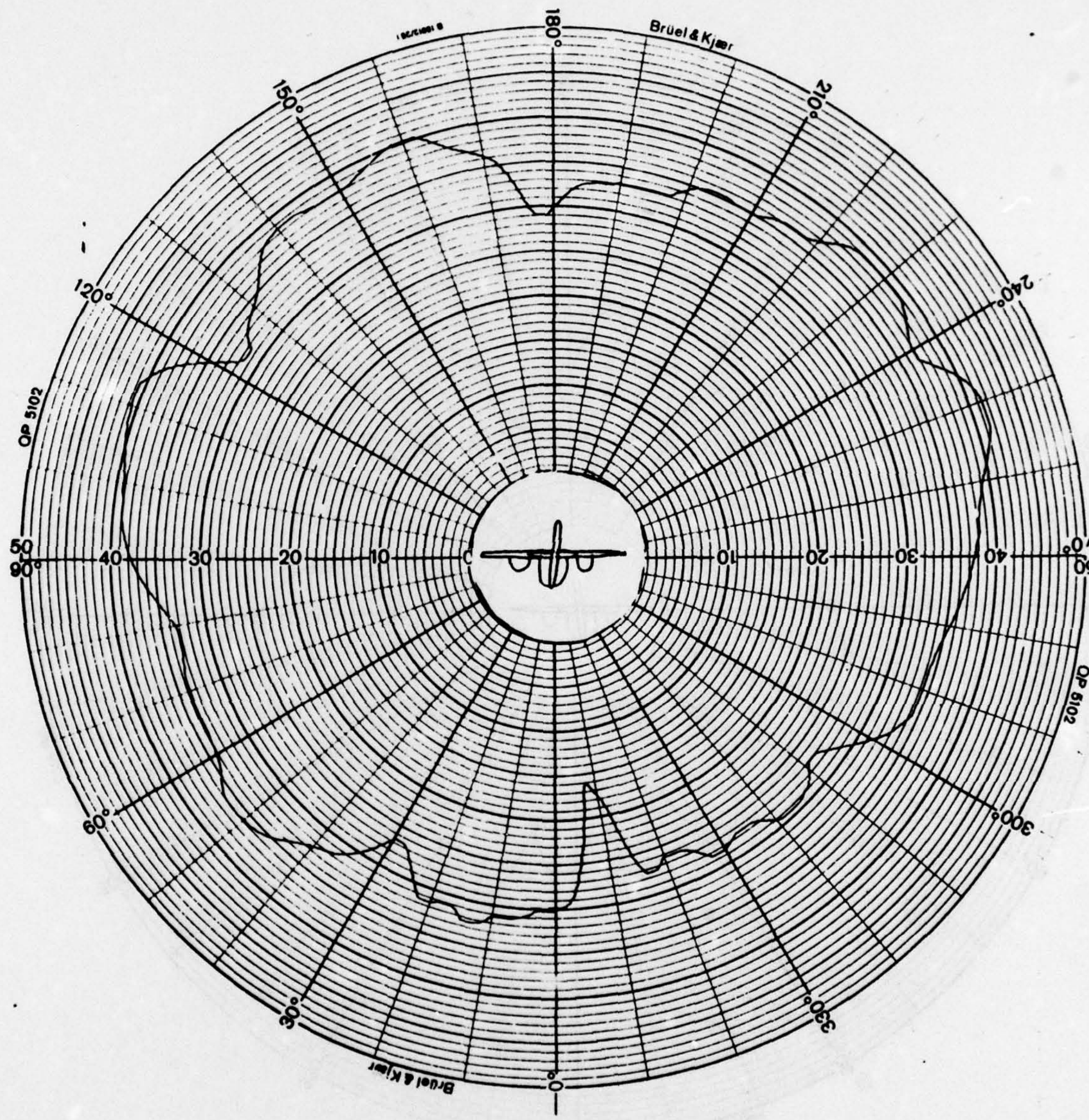
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)

PLOT NO. 64 *POLARIZATION* E_O ✓ E_ϕ ____

PATTERN PLANE YAW ____ *PITCH* ✓ *ROLL* ____

ANTENNA TYPE VHF-FM

ANTENNA LOCATION BELLY-REAR COD POSITION



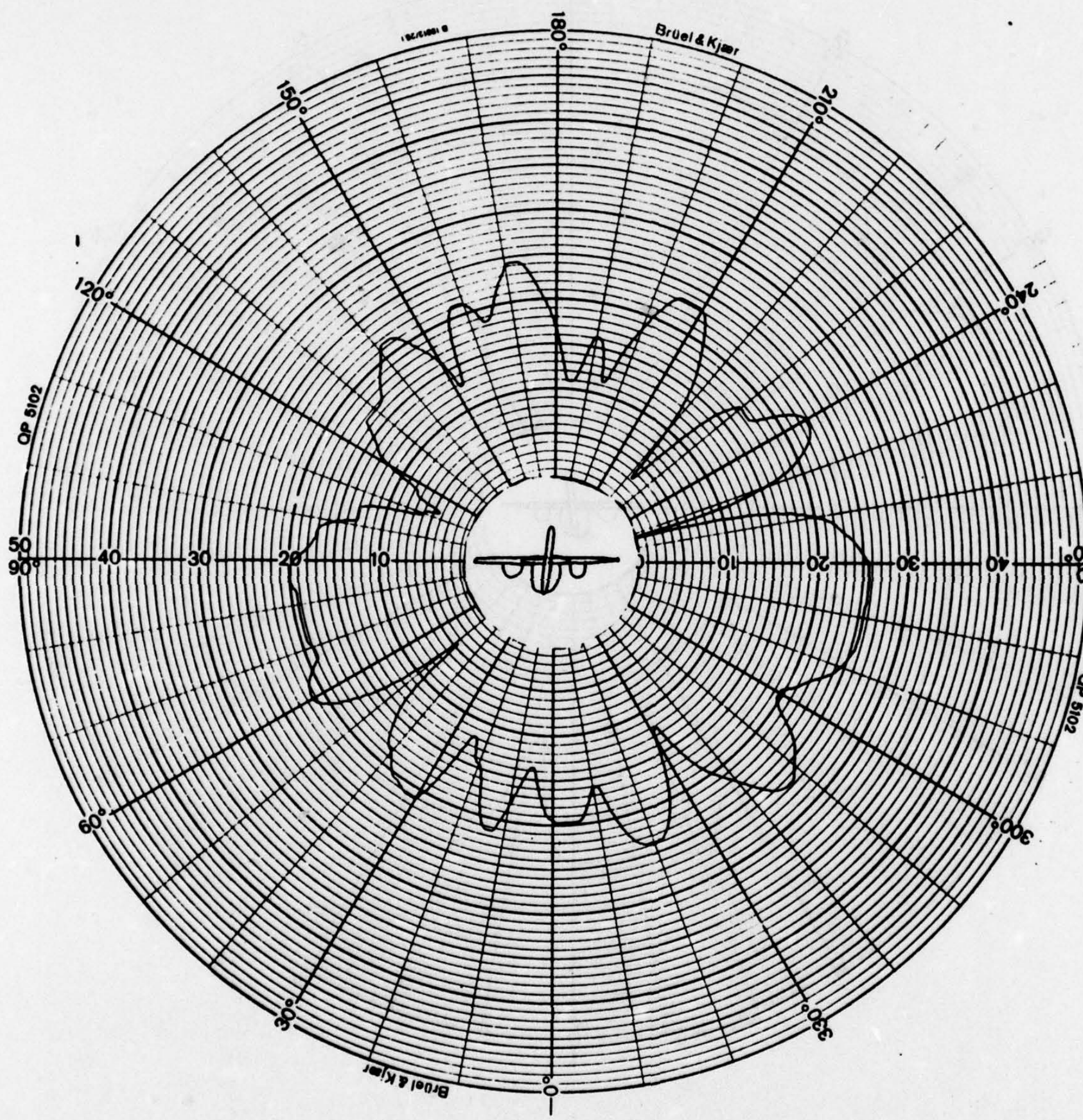
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)

PLOT NO. 65 *POLARIZATION* E_θ ✓ E_ϕ ____

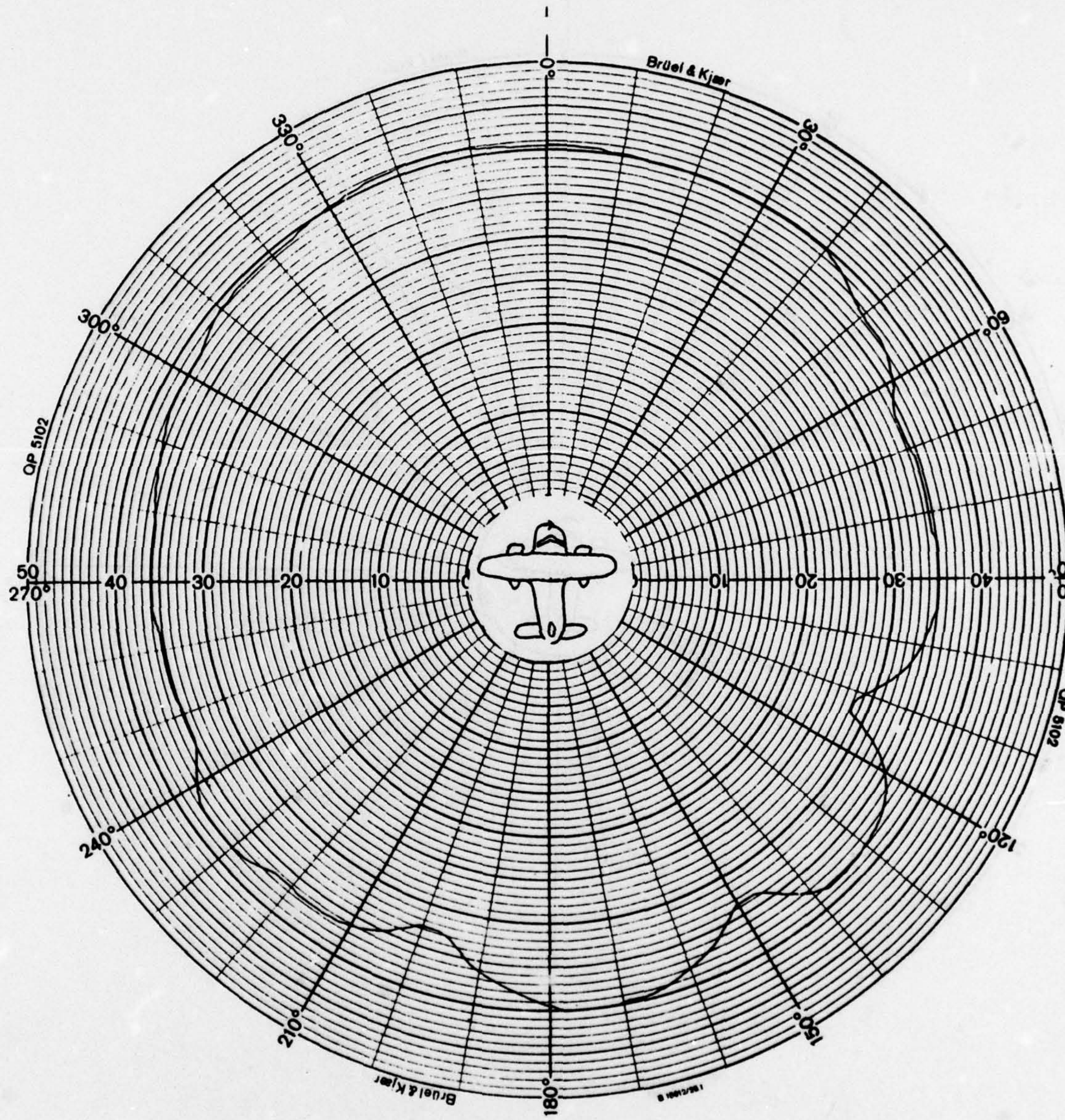
PATTERN PLANE YAW ____ *PITCH* ____ *ROLL* ✓

ANTENNA TYPE VHF-FM

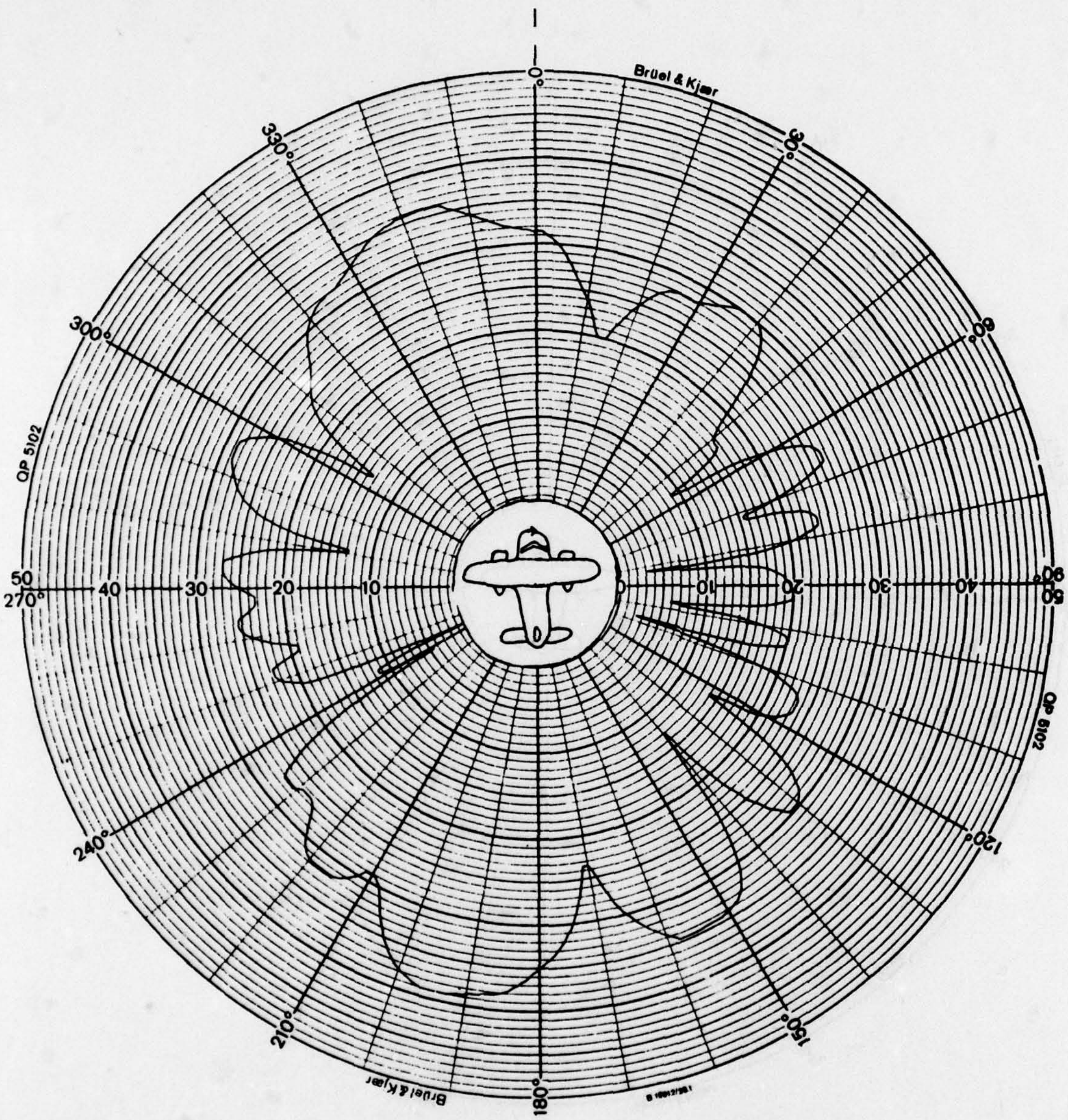
ANTENNA LOCATION BELLY-REAR COD POSITION



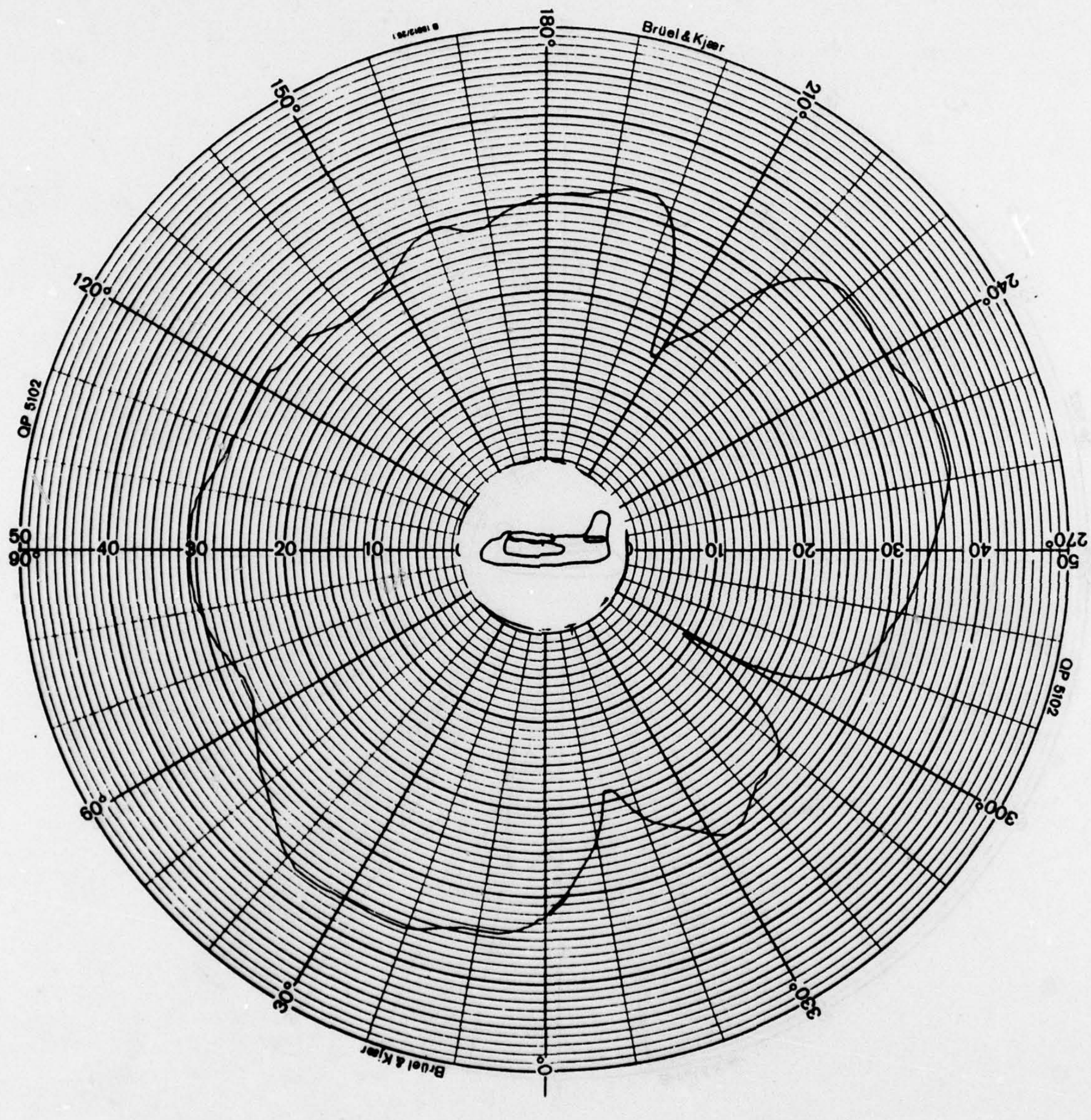
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 66 *POLARIZATION* E_{O} ___ E_{ϕ} ✓
PATTERN PLANE YAW ___ *PITCH* ___ *ROLL* ✓
ANTENNA TYPE VHF-FM
ANTENNA LOCATION BELLY-REAR COD POSITION



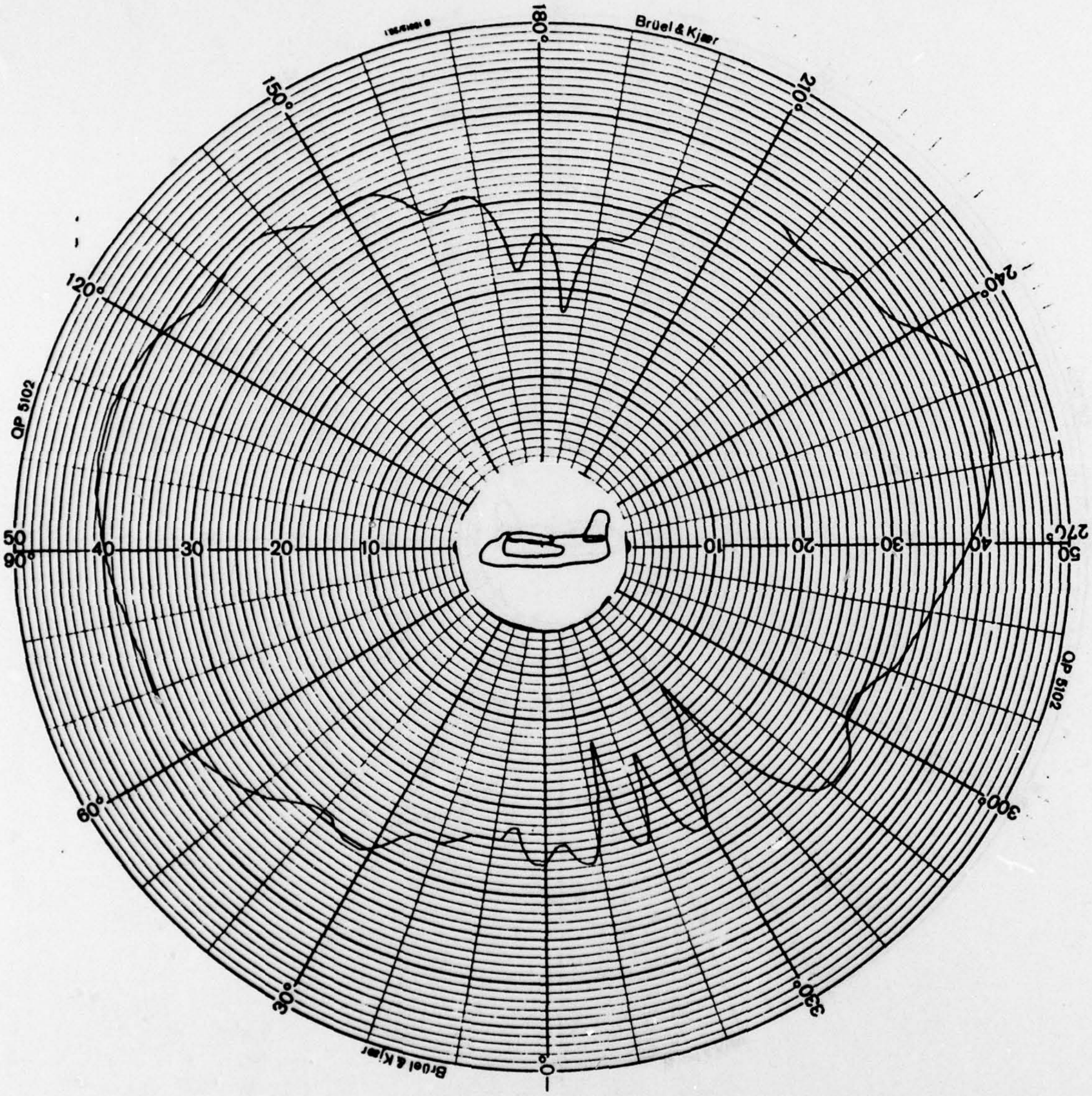
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 67 *POLARIZATION* E_{Θ} ✓ E_{ϕ} ___
PATTERN PLANE YAW ✓ *PITCH* ___ *ROLL* ___
ANTENNA TYPE VHF-AM
ANTENNA LOCATION BELLY-REAR COD POSITION



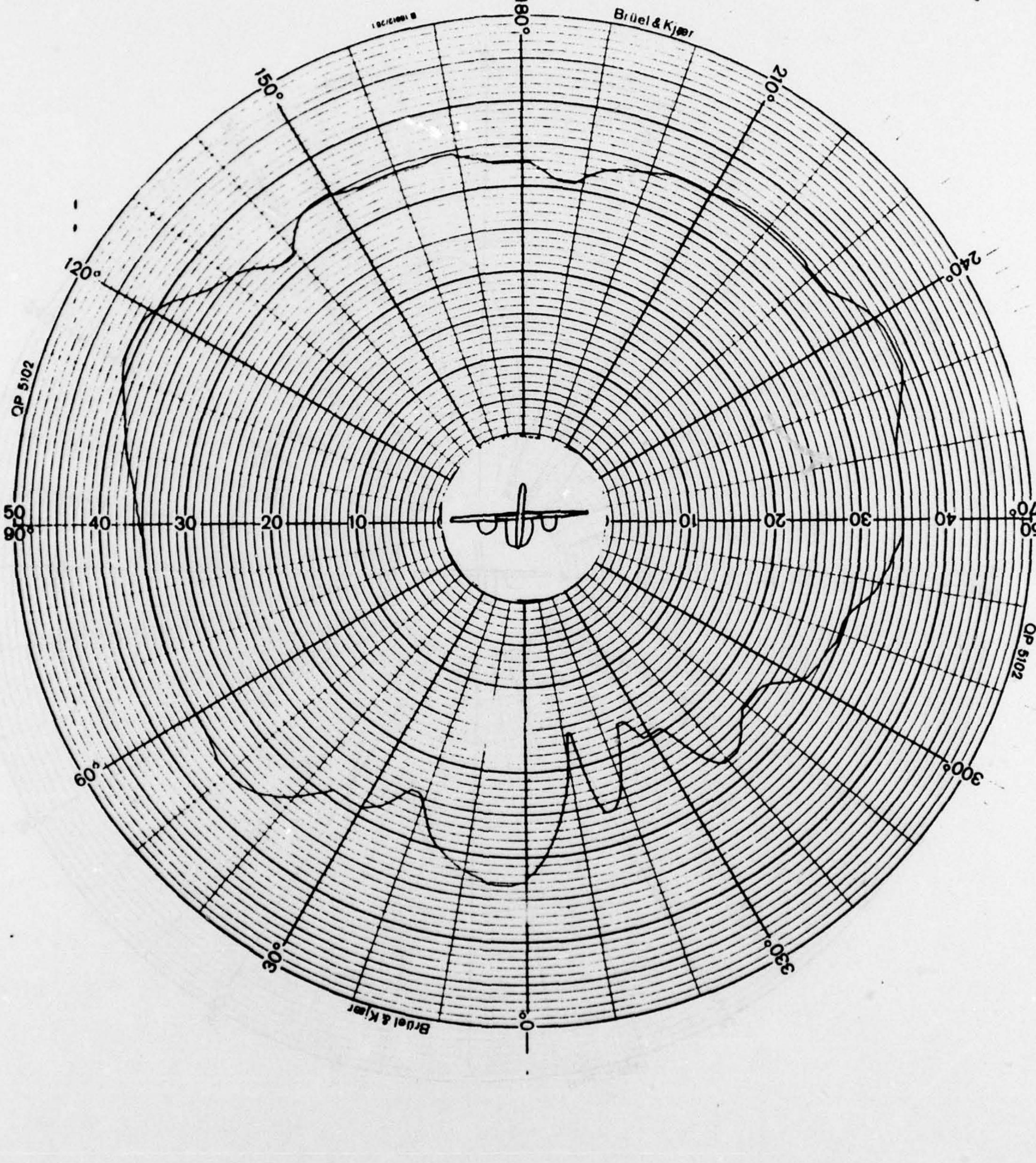
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 68 *POLARIZATION* E_{Θ} ___ E_{ϕ} ✓
PATTERN PLANE YAW ✓ *PITCH* ___ *ROLL* ___
ANTENNA TYPE VHF-AM
ANTENNA LOCATION BELLY-REAR COD POSITION



TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 69 *POLARIZATION* E_θ ___ E_ϕ ✓
PATTERN PLANE YAW ___ *PITCH* ✓ *ROLL* ___
ANTENNA TYPE VHF-AM
ANTENNA LOCATION BELLY-REAR COD POSITION



TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 70 *POLARIZATION* E_Θ ✓ E_ϕ ___
PATTERN PLANE YAW ___ *PITCH* ✓ *ROLL* ___
ANTENNA TYPE VHF-AM
ANTENNA LOCATION BELLY-REAR COD POSITION



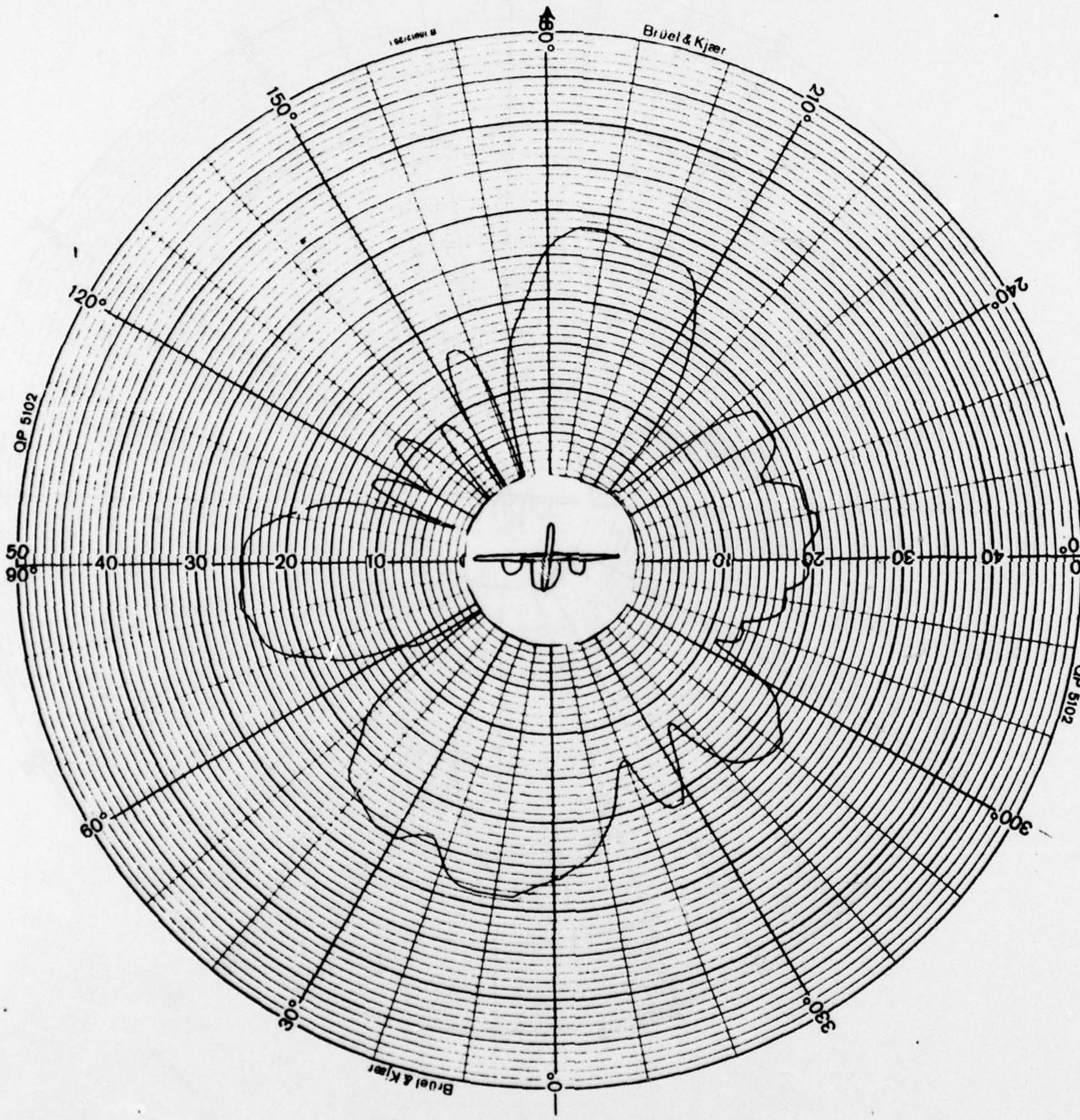
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)

PLOT NO. 71 *POLARIZATION* E_θ ✓ E_ϕ ____

PATTERN PLANE YAW ____ *PITCH* ____ *ROLL* ✓

ANTENNA TYPE VHF-AM

ANTENNA LOCATION BELLY-REAR COD POSITION



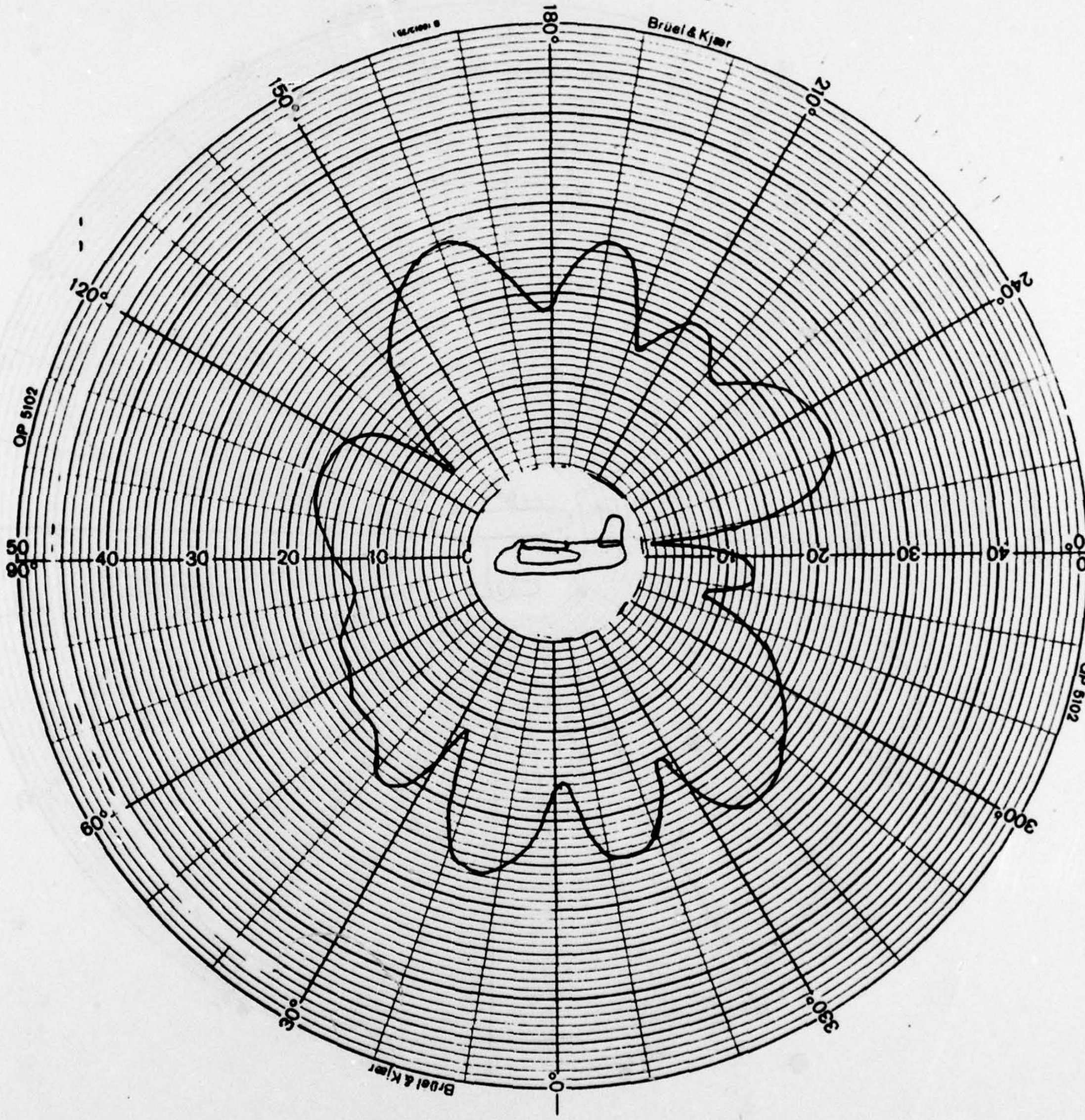
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)

PLOT NO. 72 *POLARIZATION* E_θ ____ E_ϕ ✓

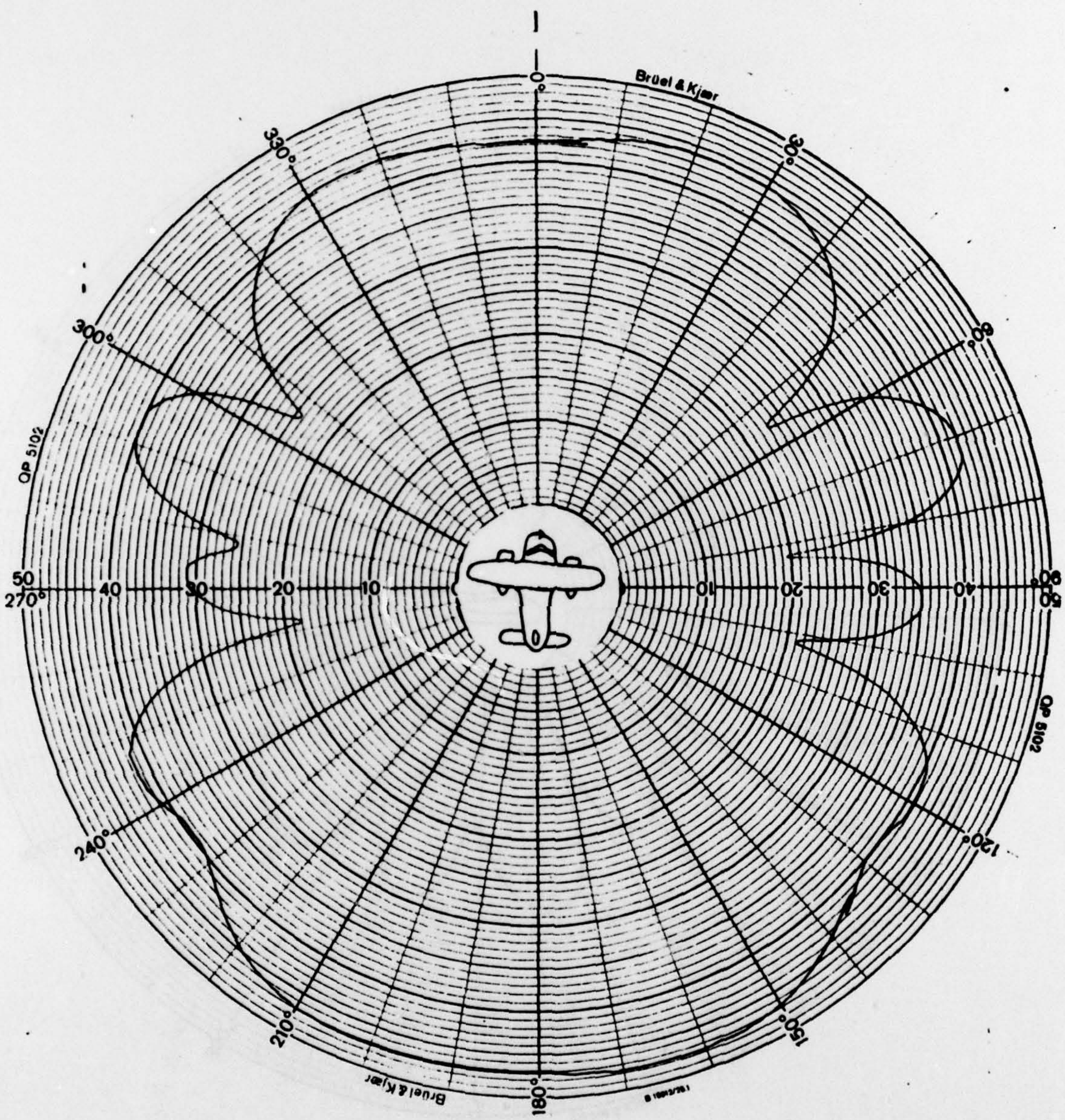
PATTERN PLANE YAW ____ *PITCH* ____ *ROLL* ✓

ANTENNA TYPE VHF-AM

ANTENNA LOCATION BELLY-REAR COD POSITION



TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 73 *POLARIZATION* E_θ ___ E_ϕ ✓
PATTERN PLANE *YAW* ___ *PITCH* ✓ *ROLL* ___
ANTENNA TYPE MARKER BEACON
ANTENNA LOCATION BELLY



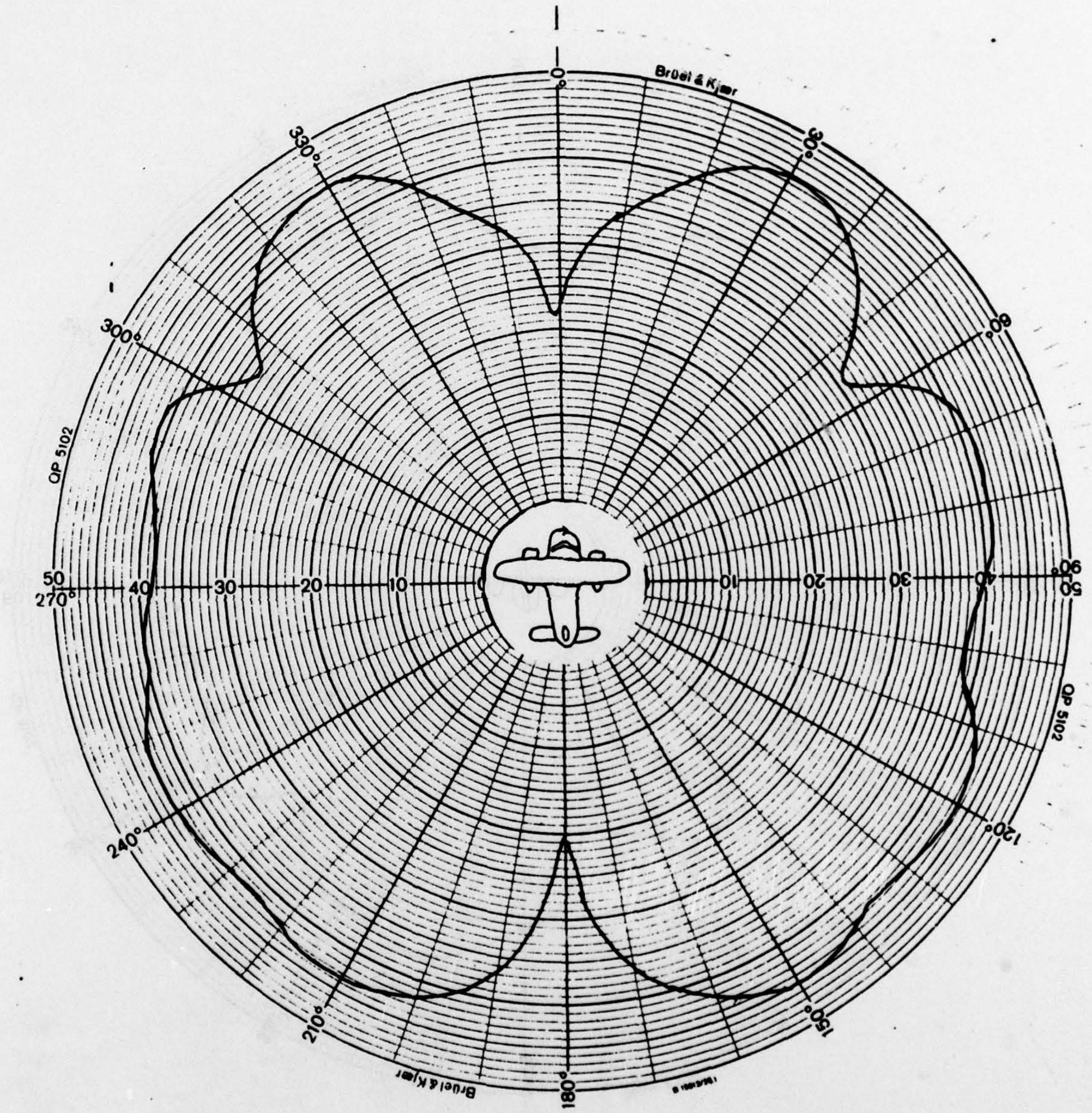
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)

PLOT NO. 74 *POLARIZATION* E_θ ✓ E_ϕ ____

PATTERN PLANE *YAW* ✓ *PITCH* ____ *ROLL* ____

ANTENNA TYPE MARKER BEACON

ANTENNA LOCATION BELLY



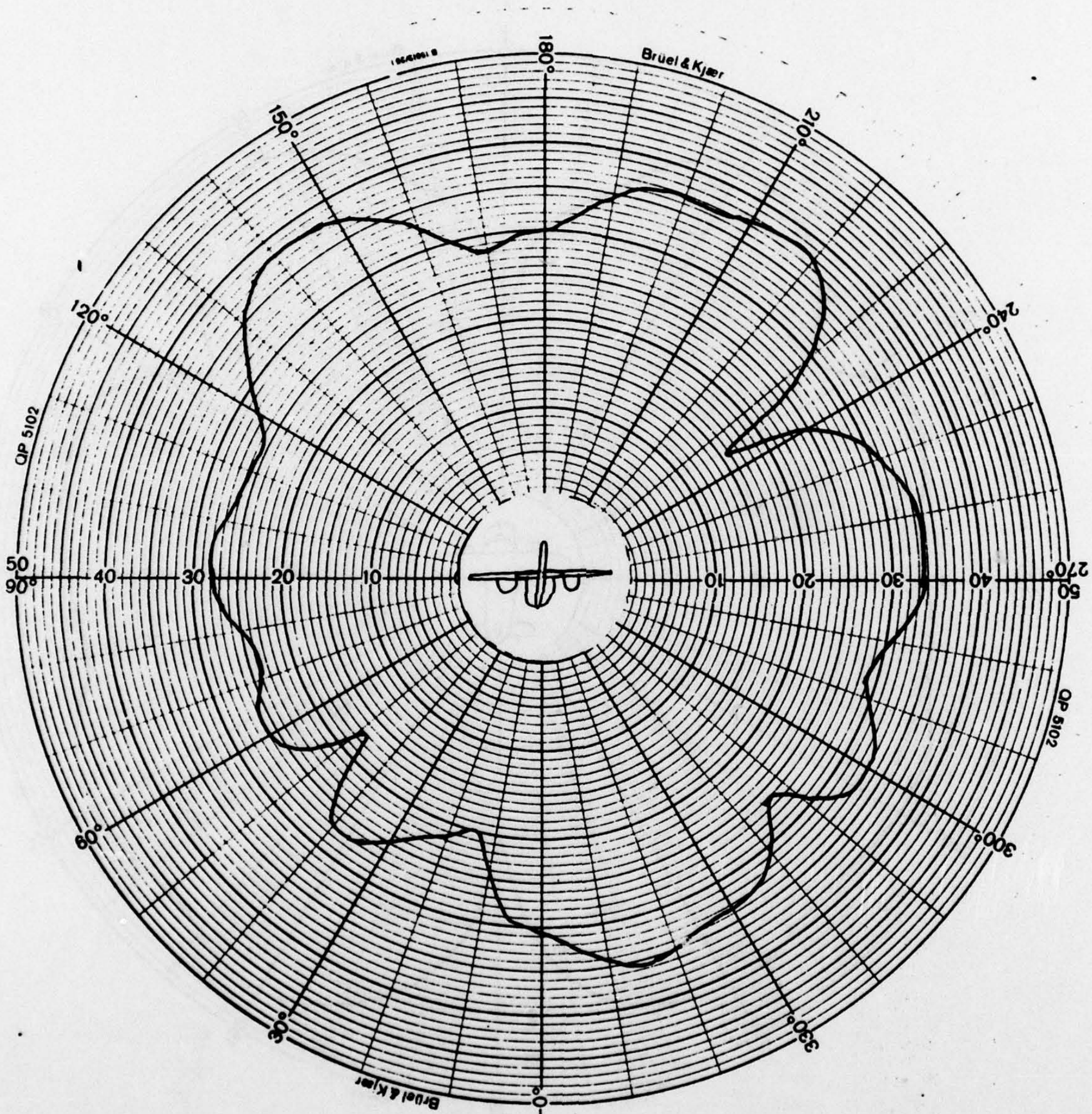
TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)

PLOT NO. 75 *POLARIZATION* E_θ ___ E_ϕ ✓

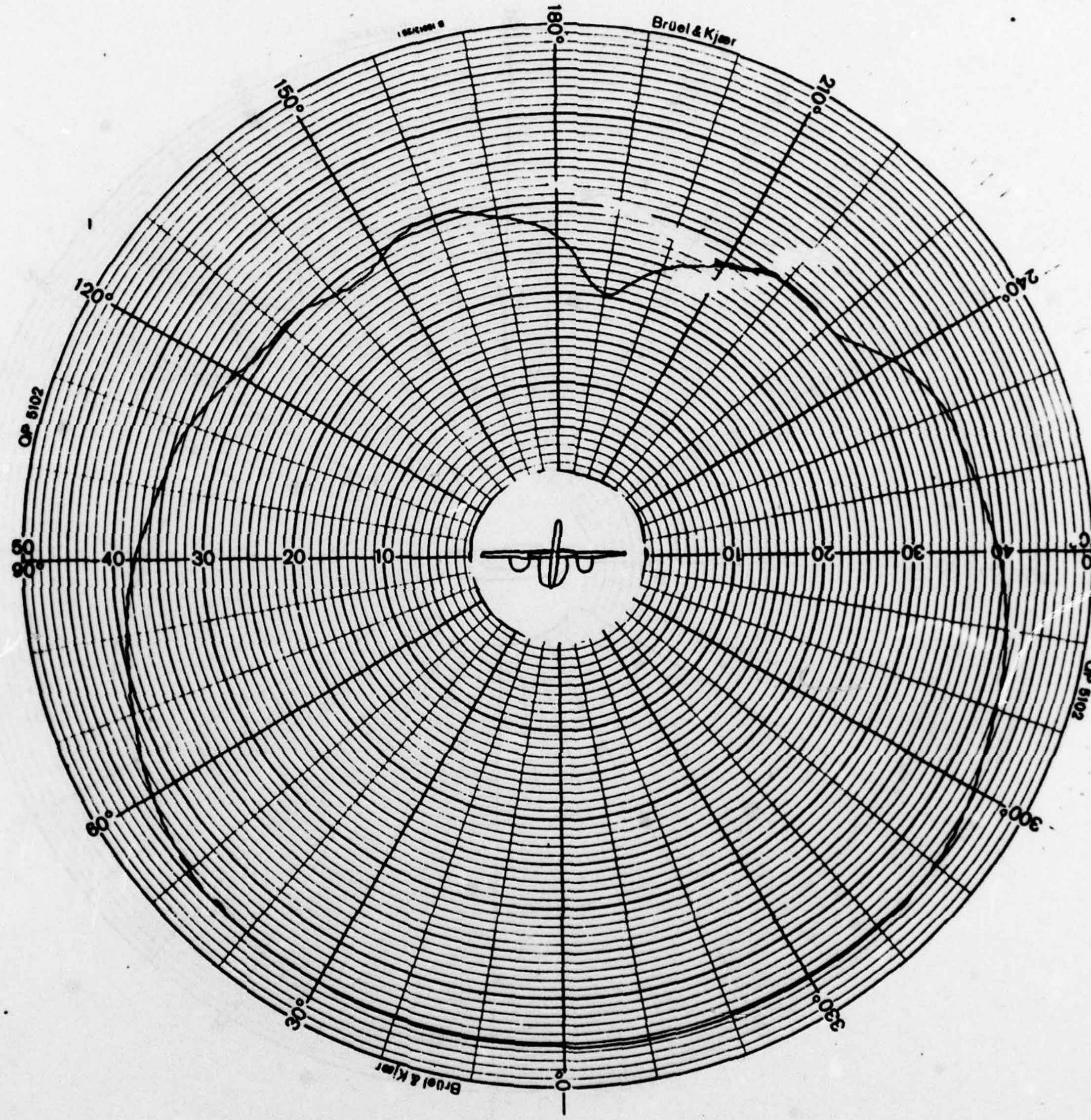
PATTERN PLANE YAW ✓ *PITCH* ___ *ROLL* ___

ANTENNA TYPE MARKER BEACON

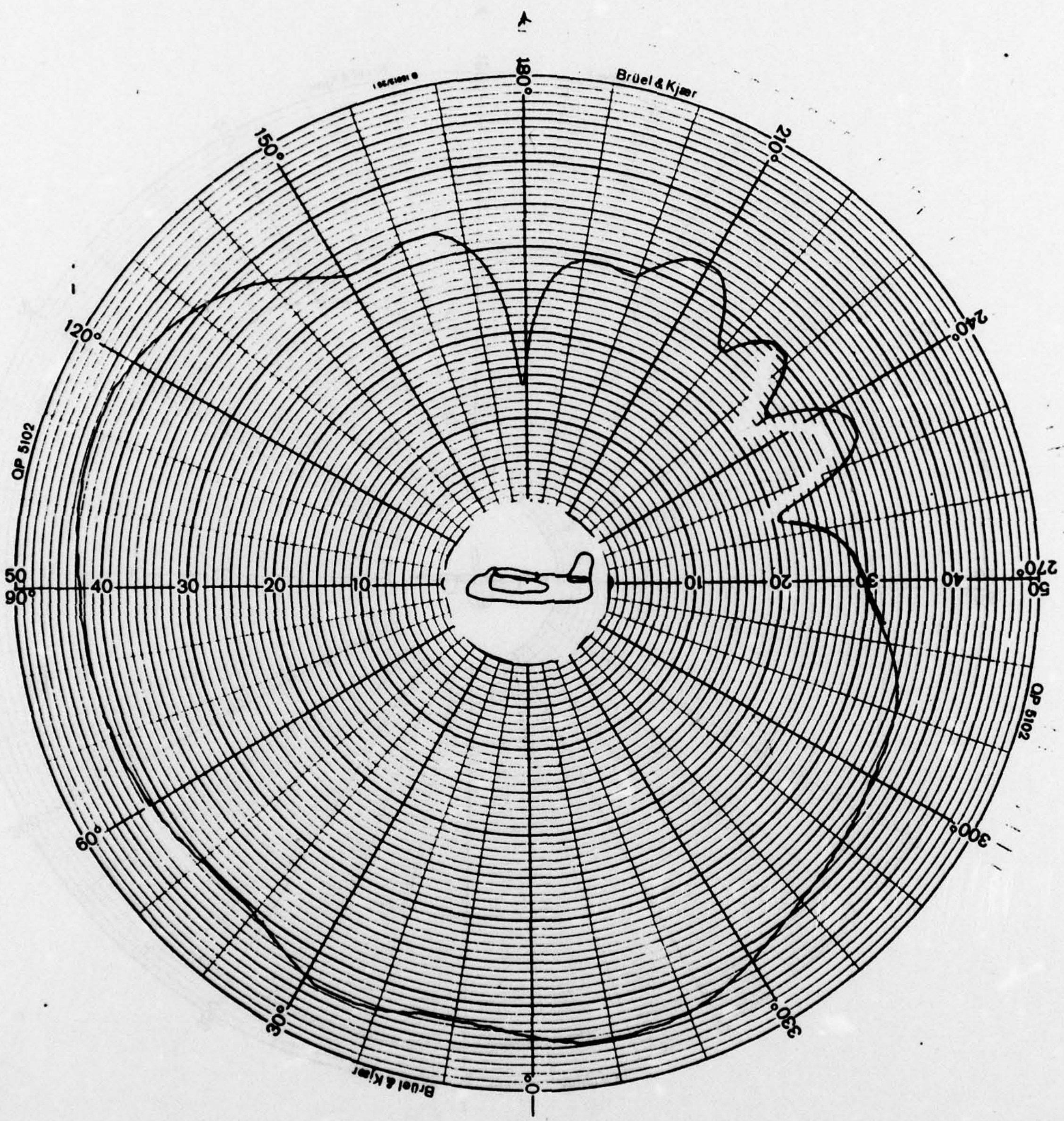
ANTENNA LOCATION BELLY



TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 76 *POLARIZATION* E_θ ✓ E_ϕ ____
PATTERN PLANE YAW ____ *PITCH* ____ *ROLL* ✓
ANTENNA TYPE MARKER BEACON
ANTENNA LOCATION BELLY



TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)
PLOT NO. 77 *POLARIZATION* E_θ ____ E_ϕ ✓
PATTERN PLANE *YAW* ____ *PITCH* ____ *ROLL* ✓
ANTENNA TYPE MARKER BEACON
ANTENNA LOCATION BELLY



TRACKER AIRCRAFT ANTENNA PATTERNS (POLAR PLOTS)

PLOT NO. 78 *POLARIZATION* E_θ ✓ E_ϕ ____

PATTERN PLANE YAW ____ *PITCH* ✓ *ROLL* ____

ANTENNA TYPE MARKER BEACON

ANTENNA LOCATION BELLY

REFERENCES

1. J.D. Kraus, Antenna, New York; McGraw Hill, 1950, pp 17 - 19,1969, pp 85-90.

2. G. Hasserjiam and A. Ishimaru, Excitation of a Conducting Cylindrical Surface of Large Radius of Curvature, "Transactions of the IRE, Vol. AP-10, No. 3, May 1962, pp 264-273.

3. J.B. Keller, "Geometrical Theory of Diffraction", Journal of the Optical Society of America. Vol. 52, No. 3 pp 116-130 Feb. 1962.

4. M. Born and E. Wolf Principles of Optics, New York: MacMillan Company, 1959, pp 530-590.

5. D.R. White, EMC Handbook, Don White Consultants, Inc., 1973 P 4.11.

6. J.P. Whelpton, "Antenna Modelling of Communications, Navigation, and Instrument Landing System Antennas for the Grumman Tracker Aircraft". CRC Technical Memorandum 74/77, Nov. 30/77.

APPENDIX 1

Power density is given by:

$$P_D = \frac{P_o \times G_T}{4\pi r^2} \times 2 \sin (h_A \sin \alpha)^*$$

where P_D = power density at distance r(cm) from transmit antenna (W/cm^2)

P_O = Power transmitted (watts)

G_T = Gain of transmit antenna

α = elevation angle of transmit antenna main beam

h_A = height of transmit antenna above ground (cm)

The term 2 sin (h_A sin α) corrects for proximity of ground.

For Glide Slope ground installation P_O is 1.5 watts,

G_T is 13 db or 19.95, α is taken as 2.5,

h_A is 4.32m.

The power density at 10 nautical miles is then 1.29×10^{-12} W/cm^2.

power received is given by:

$P_R = P_D \times Aeff$ Aeff is antenna effective area

or

$$P_R = \frac{P_D \times G_R \times \lambda^2}{4\pi}$$

With a receive antenna gain of 2 db above isotropic at 330 MHz the power received at 10 nautical miles is 1.34×10^{-9} watts.

For a receiver with an input impedance of 50 Ω the receive signal would be 258.7 μv.

*J.D., Kraus, Antennas, New York, McGraw-Hill, 1950, P. 308.

Table 8 and Table 9 give the received power and received signal in μv for different attitudes of the aircraft. The degradation in gain of the receive antenna from maximum is given. This was obtained from the antenna pattern measurements. Maximum antenna gain was assumed to be 2db above isotropic

TABLE 8

Receive signal at 10 nautical miles with P_D calculated from installation specifications.

Angles(0)* Azimuth (ϕ)	Elevation (Θ)	G_R Degradation (db)	G_R(db)	Power rec'd (watts)	Received Signal (μv)
		0.0	2.0	1.34×10^{-9}	259
0.0	92.5	2.5	-0.5	7.55×10^{-10}	194
0.0	102.5	4.0	-2.0	5.54×10^{-10}	166
±60.0	102.5	6.5	-4.5	3.00×10^{-10}	122

TABLE 9

Receive signal at 10 nautical miles assuming DOT minimum power density of 400 μv/m (-95 dbW/m^2)

Angles* Azimuth	Elevation	G_R Degradation (db)	G_R(db)	Power rec'd (watts)	Received Signal (μv)
		0.0	2.0	3.28×10^{-11}	40
0.0	92.5	2.5	-0.5	1.85×10^{-11}	30
0.0	102.5	4.0	-2.0	1.30×10^{-11}	26
±60.0	102.5	6.5	-4.5	7.37×10^{-12}	19

* 0°Azimuth - nose on
90° Elevation - horizontal plane

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13. ABSTRACT

This report details the antenna location study for the Tracker Aircraft refitment. Computer prediction of electromagnetic interference and antenna coupling in conjunction with antenna pattern measurements made on a scale model of the Tracker yielded suggested locations for the new antennas.

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